IN THE MATTER OF:

SCM CORPORATION
Quarantine Road Landfill

SERVE ON:

Corporation Trust, Inc.
32 South Street
Baltimore, Maryland 21202

DEPARTMENT OF HEALTH AND MENTAL HYGIENE

WASTE MANAGEMENT ADMINISTRATION
201 West Preston Street
Baltimore, Maryland 21201

C-O-85-139 (Amended)

* * * * * * *

AMENDED ORDER

WHEREAS, on December 17, 1984, the State of Maryland, Department of Health and Mental Hygiene, Waste Management Administration ("WMA"), issued a Complaint and Order to the SCM Corporation ("SCM") concerning its Quarantine Road Landfill.

WHEREAS, the December 17, 1984 Complaint and Order addressed two separate matters: (1) a leachate outbreak from the landfill operation and (2) various groundwater monitoring matters concerning the hazardous waste cell.

WHEREAS, WMA now concedes that, in the portion of the December 17, 1984 Complaint and Order concerning groundwater monitoring of the hazardous waste cell, WMA mistakingly cited various provisions of COMAR 10.51.05.06 in lieu of the correct regulatory provisions which are contained at 40 C.F.R. 265.90 *et seq*. See COMAR 10.51.05.06A(4).

WHEREAS, WMA still contends that SCM has not conducted groundwater monitoring of the hazardous waste cell as required by applicable requirements and therefore WMA may issue a revised Complaint and Order citing the correct regulations.

WHEREAS, SCM is developing a program for groundwater monitoring of the entire landfill, which, if approved by WMA and if carried out by SCM, may obviate the need for further groundwater monitoring of the hazardous waste cell.

THEREFORE, it is ORDERED by the Director of WMA that:

1. Effective immediately, those provisions of the December 17, 1984 Complaint and Order concerning groundwater monitoring of the hazardous waste cell are hereby withdrawn. Specifically, WMA withdraws paragraphs 2, 3 and 4 of the December 17, 1984 Complaint and Order. Paragraph 1 remains fully in effect.

March 18, 1985
Date

Ronald Nelson
Ronald Nelson, Director
Waste Management Administration

Jeffrey E. Howard
Jeffrey E. Howard
Assistant Attorney General

APPENDIX H

Environmental Resources Management, Inc.

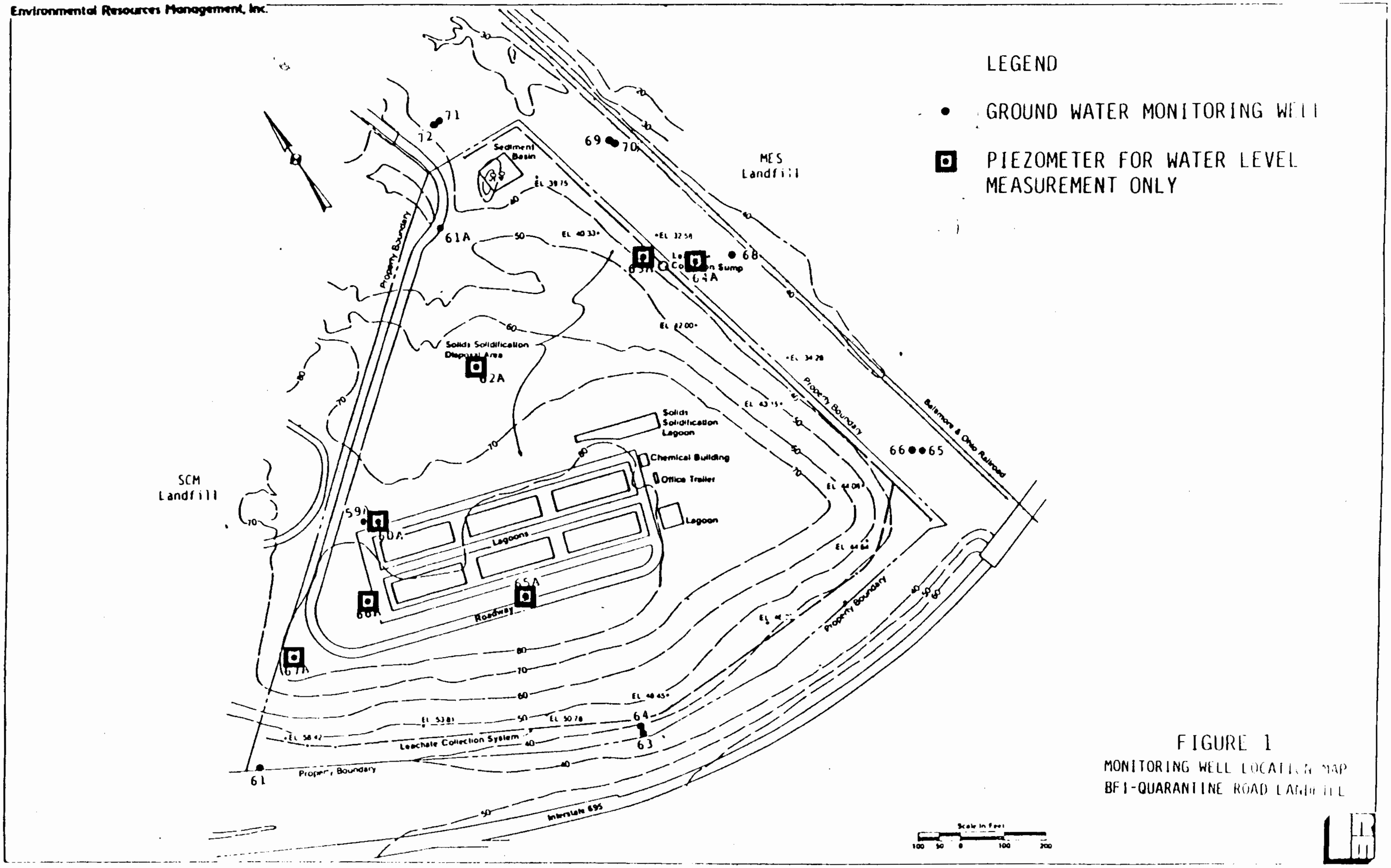
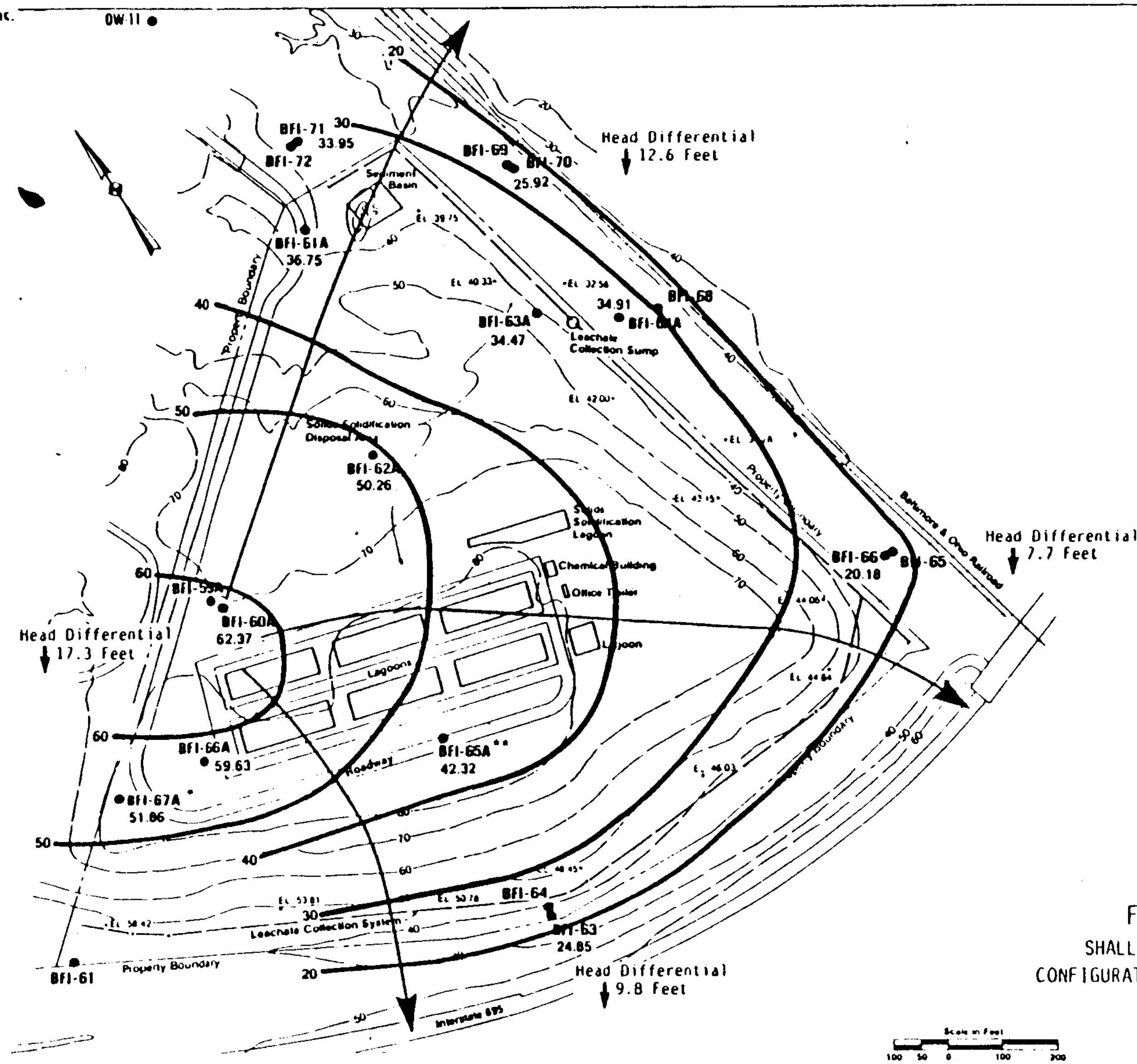


FIGURE 1
MONITORING WELL LOCATION MAP
BFI-QUARANTINE ROAD LANDFILL

Environmental Resources Management, Inc.



Note:

- * Actual date of water level for BFI-67A, April 10, 1982.
- ** Actual date of water level for BFI-65A, August 13, 1982.
- ↓ Indicates direction of head differential.

FIGURE 2

SHALLOW WATER TABLE CONFIGURATION, OCTOBER, 1982

Environmental Resources Management, Inc.

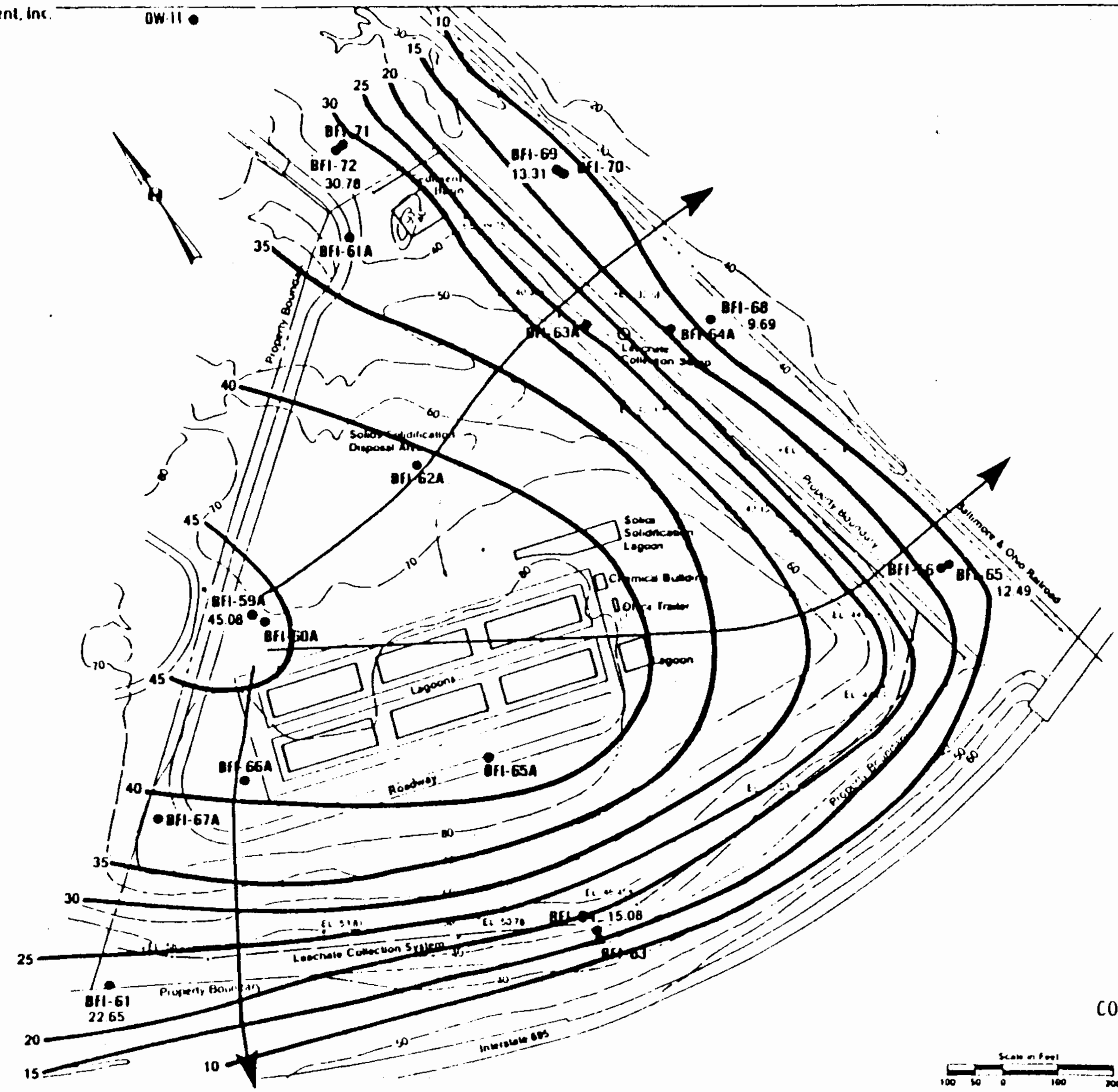


FIGURE 3
DEEP WATER TABLE
CONFIGURATION, OCTOBER, 1982

Note:

* Actual date of water level for BFI-59A, April, 1982.

APPENDIX I

CHEMICAL/METALLURGICAL

Division of

SCM CORPORATION

RECEIVED

SEP 3 1980

DIVISION OF SOLID WASTES

PRELIMINARY

AUG 28 1980

QUARANTINE ROAD SECURE LANDFILL

PART I — SECURE LANDFILL

OPERATING PLAN AND PROCEDURES

D R A F T

August, 1980

HARRINGTON, LACEY & ASSOCIATES, INC.

ENGINEERS

TABLE OF CONTENTS

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CHAPTER I

INTRODUCTION

Background:

The proposed Quarantine Road Secure Solid Waste Fill consists of privately-owned property located in the Curtis Bay industrial area of Baltimore City. The tract is owned by the Chemical/Metallurgical Division of SCM Corporation (SCM), and it has been used for general industrial storage and periodic waste dumping for an extended period.

In order to efficiently design and operate the site as a secure landfill, SCM is applying for the necessary permit and will be responsible for the operation. Designated Hazardous Substances (DHS) will be disposed of at the Quarantine Road fill, along with non-hazardous operational waste from the plant. Therefore, the disposal operation will require a State Designated Hazardous Substances Permit.

The site has been evaluated and designed in accordance with current fill procedures for secure solid waste fills.

Site:

The proposed Quarantine Road Secure Landfill consists of approximately 50 acres of land owned by the SCM Corporation.

The proposed facility, located in the southeast corner of Baltimore City, is bounded on the west by Quarantine Road, on the northeast by the Baltimore and Ohio Railway, and on the south by the existing Quarantine Road Sanitary Landfill, operated by BFI. The Vicinity Map indicates the approximate boundaries of the proposed project, and the surrounding land use within 1000 feet of the site.

The subject property and adjacent lands are zoned mainly for industrial usage. However, the land in the immediate vicinity of the site is generally undeveloped.

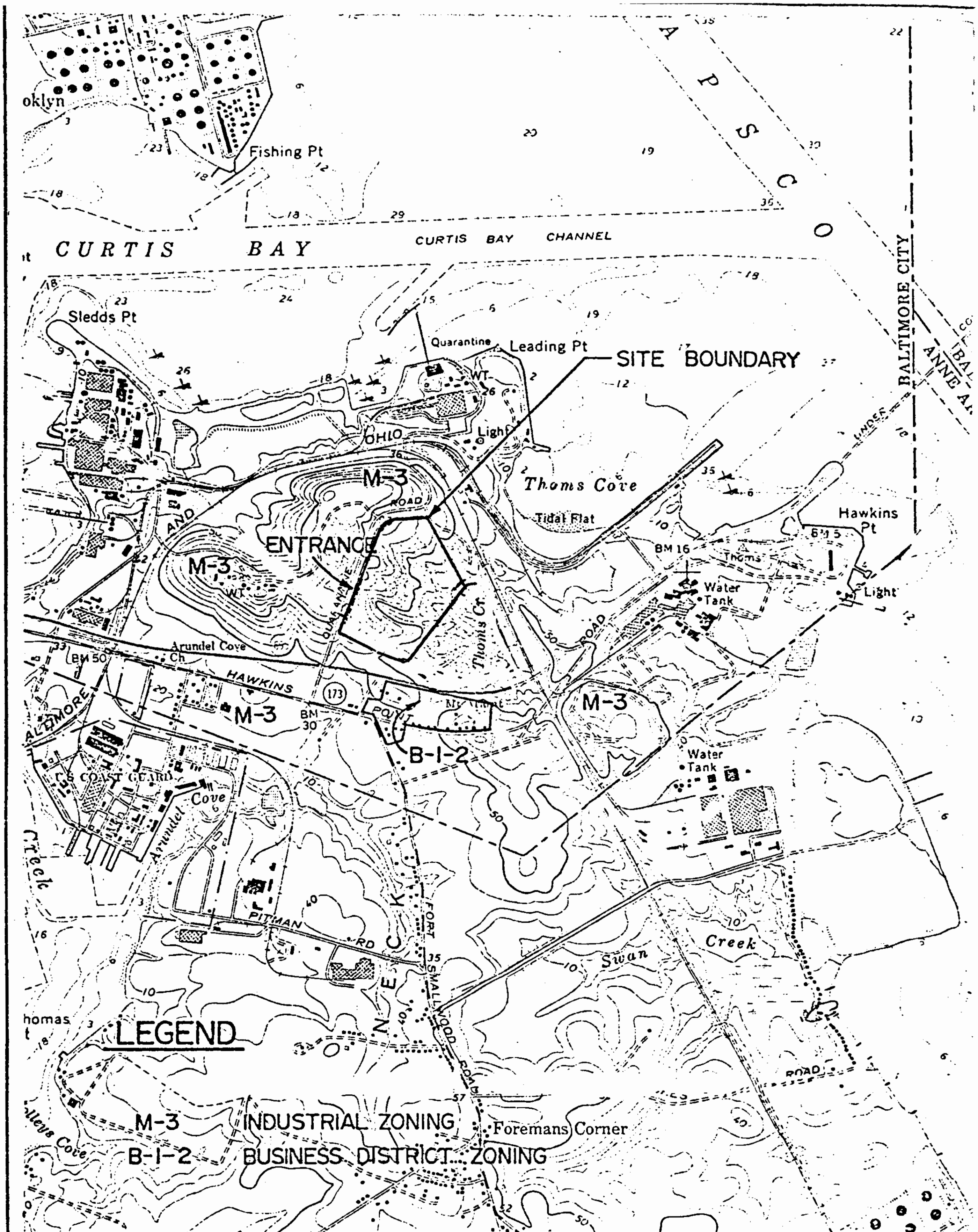
The general area is currently served by Baltimore City's central water system. Also, several industrial wells exist within the general area, according to records on file with the Maryland Water Resources Administration.

Topography and Drainage:

The topography of the site is the result of the numerous excavation, fill, and generally uncontrolled activities which have occurred through the site's history. The highest elevation occurs along the western boundary at approximately 104 feet above sea level. From there, the ground surface slopes eastward to lower elevations at approximately 30 to 35 feet above sea level.

The site topography used for the detailed design was determined by aerial photogrammetry and prepared at the scale of 1-inch equals 100 feet, with a 2-foot contour interval (Maps, Inc.; Sept., 1979). As required, field surveys were subsequently performed in April, 1979, to update the existing topography. Northeast of the B & O Railroad Line, U.S. Geological survey topography was used to extend the contour lines in order to provide an approximate configuration of that off-site area. The detailed design, and the construction of Secure fill support facilities were based on additional field surveys, as required.

The fill design provides for maximum site usage of the tract. Therefore, the final topography of the operating area will be a combination of filled excavations and general area fill. The top elevation will be approximately 192 feet above sea level near the center of the site.



QUARANTINE ROAD SECURE LANDFILL

1" = 2000'

FIGURE I-1

VICINITY MAP

All surface water runoff in the area either is diverted away from or transverses the site toward a 24-inch culvert located in a 36-inch sleeve under the B & O Railway track. The runoff, eventually, flows into Thoms Creek, which empties into Thoms Cove and the Patapsco River.

Surface drainage will be controlled through the design and construction of proper drainage diversions. The attached design drawings provide for permanent diversion ditches located on the site, to carry runoff toward the sediment control facilities at the eastern side of the operating area. Sediment control and storm water management are provided for the fill design, according to the requirements of the U.S. Soil Conservation Service and the Baltimore City Design Manual.

CHAPTER II

SUBSURFACE INVESTIGATION

General:

The geology and hydrology were determine evaluating sub-surface investigation data which were develop the site or in conjunction with other projects located in th cinity of the Quarantine Road area.

The field work completed during May, Ju d August of 1978 by Atec Associates, Inc. of Maryland consist eleven (11) test borings located on or adjacent to the propert Also, nine (9) well points were installed in order to monitor th oundwater level. The borings were drilled to depths ranging be en 50.0 feet and 90.0 feet below existing ground surface, and exter g at least 15 feet into the ground water table. Split spoon anc elby Tube samples were taken, and laboratory tests were perform n the sediments to determine textural classification; particle s distribution curves; Cation Exchange Capacity; and pH. These bor and laboratory testing results are included in Appendix A.

Geologic and hydrologic work that was c ted in the general vicinity of the site prior to 1978 was also e ated, including the following:

a. Borings and other data from the Engi ing Feasibility Report, Proposed Quarantine Road Lar l, Curtis Bay, Maryland, prepared in 1976 by MCA En ering Corporation (B-Series; OW-1 to OW-4),

b. Hydrological Investigation of the Ha s Point Chrome Ore Tailings Disposal Site, prepared by Maryland Water Resources Administration in 1977,

c. Borings taken by the Maryland State Highway Administration prior to the construction of the section of Interstate 695 along the south side of the site, (Baltimore Harbor Outer Crossing - Master Soils Plan and Profile - State Highway Commission, Contract No. OT-4-2),

d. Various industrial wells within one (1) mile of the site including the Glidden-Durkee Well, #4S4E-1, which is screened in the Patuxent Formation from 565 to 575 feet below sea level.

The pertinent boring and sediment data obtained from the aforementioned reports are contained in Appendix B of this report. The well data has been plotted on regional maps and included in Appendix C.

Geologic and Hydrologic Background:

The proposed Quarantine Road Secure Landfill is within the Coastal Plain Sediments characteristic of the region comprised of northern Anne Arundel County, Baltimore City and Baltimore County. The Geologic Map of Maryland (1968) shows the sediments as belonging to the Potomac Group, consisting of the youngest Patapsco Formation, the intermediate Arundel Clay, and the oldest Patuxent Formation.[1]

The sand and clay facies of the Patapsco Formation are exposed at and in the vicinity of the site with late Tertiary-Quaternary upland gravels above the lower Cretaceous beds. Crowley, et.al., summarized the geology of the Patapsco facies in the recently published Geologic Map of Baltimore County and City (1976):

> Clay facies (1.5 to 165 feet thick): typically buff, red-yellow, and brown mottled kaolinitic clays. Variable amounts of quartz sand and silt as pods and interbeds, dispersed throughout the clay... Deposition in oxidized flood plain-mud flat environment is postulated.

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[1] Cleaves, Emery T., Jonathan Edwards, Jr., and John D. Glaser, Geologic Map of Maryland, Maryland Geological Survey (Baltimore: 1968).

Sand facies (1.5 to 100 feet thick): well-sorted, medium to fine grained quartz sand with locally abundant quartz gravel and clay clasts. Minimal clay-silt matrix in sand interstices... Deposition in and around channels of low gradient streams.[2]

Groundwater at the Quarantine Road site is a complex system which appears to include perched water as well as a groundwater table condition. A representative of the U.S. Geological Survey stated that a previous investigation was not able to comprehend the range of ground water elevation from 88 feet above sea level to several below sea level readings due to the probable existence of perched water.[3]

The potentiometric elevation is at sea level through the middle of the site along an east/west axis as shown on the Ground Water Map included in Appendix E. The groundwater surface north and south of that axis varies approximately several feet above and below sea level.[4]

Based on the geologic and hydrologic data reported in the literature, the 1978 subsurface investigation was planned to develop the stratigraphy underlying the proposed landfill area. Interfingering beds of clays, sands and silts were expected to occur and the laboratory tests were required to determine the basic physical characteristics of the sediments.

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2 Crowley, William P. Jurgeon Reinhardt, Emery T. Cleaves, Geologic Map of Maryland, Maryland Geological Survey (Baltimore: 1968).

3 Personal communication with Frederick K. Mack, U.S.G.S., August, 1978.

4 Mack, Frederick K., Ground-Water Supplies for Industrial and Urban Development in Anne Arundel County, Maryland Geological Survey Bulletin 26 (Baltimore: 1962), 90 pp.

Boring Data:

In general, the data developed during the 1978 investigation represents the main body of work. However, the boring data contained in the aforementioned reports were considered, where appropriate.

The MCA borings B-1 through B-10 were used; however, the logs were not given for B-6, B-7 and B-10. Four (4) well points were installed during the MCA investigation; however, only OW-1 and OW-2 remain at the site. Also, the data from the 1978 borings W-14 and W-15 drilled by Atec Associates were used in lieu of MCA's OW-1 and B-1 data.

From the Water Resources Administration Hawkins Point Disposal Area report, borings B-14, B-15, B-6 and monitoring wells #1 and #2 provided useable subsurface data.

Several of the State Highway Administration borings were extended deep enough to provide useable information. Data from Borings 4L-038S, L-048, L-046, A-050, W-067, 4L-085, 4L-055, 4L-100, and L-220 and 1969 water level readings were plotted on the geologic maps in Appendix E.

Based on Atec Associates classification of the sediments according to the Unified Soil Classification System, four (4) lithologically distinct sediment types were described:

Lithology Type	Description
(1)	- Reddish brown clay to tan, very stiff to hard silty clay (CL) to clayey silt (ML)
(2)	- Brown to gray hard silty clay (CL)
(3)	- Gray to tan moist, stiff clayey silt (ML) to sand (SP)
(4)	- Tan, very dense, silty fine to medium sand (SP)

The borings indicated that the clays, silts and sands are interbedded; they occur throughout the stratigraphic column; and are consistent with the sediment descriptions given by Crowley, et. al., and Glaser.[5,6]

Based on the 1978 boring data and the data obtained from the previous subsurface work in the vicinity, eight (8) geologic sections were developed (A-A' through H-H'). The sections are shown on the geologic maps included in Appendix E of this report. Also, the various contour and isopach maps have been drawn to show the extent of the clay and sand strata which occur in the vicinity of the site.

In general, the data indicates that two clay intervals (lithology types 1 and 2) are separated by a sand unit (lithology 4) in many of the borings. Also, the sand unit tends to cover the upper clay unit in certain areas throughout the site, sometimes in conjunction with the sandy silt unit (lithology type 3). The geologic maps contained in Appendix E represent several contour maps and geologic cross-sections maps which show the general arrangement and distribution of the four (4) stratigraphic units.

In accordance with the Natural Resources Article 8-1413 2, the existence of faults, fracture systems, solution cavities, and similar geologic features was evaluated, and none were detected. Faults are difficult to determine in Coastal Plain sediments, and none are mapped in Anne Arundel County or Baltimore City and County. Similarly, fracture systems are difficult to recognize in plastic sediments such as clays; also, the destructive action of the boring process prevents recognition of fractures in sediments brought to the surface by spoon or tube sampling methods. Solution cavities are not expected in the clays because of plasticity and lack of soluble minerals. Solution cavities in the sand, if present, are not important, because the fill design will minimize the potential for transmission of potential pollution.

Sediment Analysis:

To determine the physical characteristics of the sediments, representative split spoon samples were tested in the laboratory. The tests included texture analysis, grain size distribution, natural moisture content, Atterberg Limits, Cation Exchange Capacity, and X-ray diffraction analysis. The laboratory test results are included in Appendix A of this report.

The particle size distribution curves of selected intervals in the 1978 borings are representative of the sediments which will provide the containment and/or buffering capacity in the fill. The curves indicate that more clay is present in the material than that shown by the visual classification of the split spoon samples.

The Plastic Index of the Atterberg Limits indicates that the compressibility or consistency of thirteen samples range from 0 to 24 or from none to medium with two (2) just within the lower limits of the high range. Consequently, the clay sediments within the Quarantine site consist of very soft to moderately dense silt, clayey silt, silty clay and clay. However, clayey materials predominate the area.

The Cation Exchange Capacity (CEC) was determined for nine (9) representative samples: These range from 2 to 13 MEQ per 100 grams.

The X-ray diffraction analysis of six samples confirmed that the major clays are kaolinite and kaolinite-illite; minor clays are illite in two (2) samples. The CEC data are consistent with the expected clay mineralogy of the sediments of the clays at the site.

Three (3) field permeability tests were run in lieu of laboratory permeability tests. The test locations are shown on the attached drawings. Two (2) of the tests were made in the upper clay represented by the lithology type (1) clay. The lower clay was not tested because the upper clay will provide the natural barrier. One (1) test was made in lithology type (4) sand for comparison purposes. The values are tabulated below:

Test No.	Lithology Description	K Value
#1	Type 1: Reddish brown clay to tan, very stiff to hard silty clay (CL) to clayey silt (ML)	3×10^{-6} cm./sec.
#2	Type 1: Reddish brown clay to tan, very stiff to hard silty clay (CL) to clayey silt (ML)	2×10^{-6} cm./sec.
#3	Type 4: Tan, very dense, silty fine to medium sand (SP)	3×10^{-4} cm./sec.

In general, the clayey sediments have slow permeability values within the 10^{-6} range as expected. Whereas, the silty sand sediment showed a higher permeability value typical for that material.

Upper and Lower Clays:

The geological drawings in Appendix E show clays labeled "Upper Clay" and "Lower Clay" (lithologies 1 and 2). In some of the borings, a silty sand or sand (lithologies 3 and 4) separates the upper and lower clays, but in borings OW-5, OW-13, W-14, the clays are stratigraphically continuous and the boundary has been interpreted as shown.

Elevations of the top of the upper clay are shown on the attached geologic drawings. Certain borings of MCA, State Highway Administration, and Water Resources Administration suggest that one or both clays are absent in portions of the site. Therefore, the clays appear to have the boundaries as shown on the drawings.

Crowley's descriptions of the sand and clay deposits state that the sediments were deposited on flood plains in low gradient streams and on mud flats. The distribution of the clays suggests such a pattern and the thickness of the upper clay in the northwest area of the site suggests a northwest sediment source. This concept of how the materials were formed is compatible with the data contained in the aforementioned previous investigations.

Agreement is indicated at the northwest of the site, between the thickness and the build-up of the upper clay with the supposed area of sediment transport and area of most continuous development. This indicates that the thickest development of clay occurs in the northwestern portion of the site.

Groundwater:

As previously mentioned, the data obtained from the borings and the monitoring of 11 well points indicates the existence of perched water and a ground water table condition within the site. Since the ground water level readings range in elevation from 88 feet above sea level to 12 feet below sea level, the data is not consistent enough to draw meaningful water table contours.

The true water table is located at approximately sea level, and the areas showing high and medium-high water elevations are considered to represent the perched water. The water tables shown as "low" ranging from 12 feet above to 12 feet below sea level vary also owing to the complex facies changes throughout the stratigraphic column. The cross-sections indicate where water was encountered in the observation wells.

Production Well Data:

An evaluation was made of production wells located in the Patuxent and Patapsco formations where production exceeds 10,000 gallons per day (.01 mgd), and especially with high production wells where production exceeds 1,000,000 gallons per day (1.0 mgd). The well locations and production data were obtained from the U.S. Geological Survey, the Maryland Water Resources Administration, and various technical data files and reports. The wells are shown on Exhibit 1 and Exhibit 2 included in Appendix C of this report.[7, 8]

The wells producing from the Patuxent formation are considered not affected by the location of the fill, because of the natural barrier of the overlying Arundel clay as shown on Exhibit 3 in Appendix C. The Arundel clay is at least 100 feet thick below the site

7 Lucas, Richard C., Anne Arundel County Groundwater Information: Selected Well Records, Chemical-Quality Data, Pumpage, Appropriation Data, and Selected Well Logs: Water Resources Basic Data Report No. 8, Maryland Geological Survey (Baltimore: 1976), 149 pp.

8 Laughlin, Charles P., Records of Wells and Springs in Baltimore County, Maryland: Water Resources Basic Data Report No. 1, Maryland Geological Survey, (Baltimore: 1966), 403 pp.

and is very extensively developed throughout northern Anne Arundel County, Baltimore City, and coastal plain areas of Baltimore County.[9]

The Patapsco formation occurring above the Arundel clay, and within which formation the fill is developed, has at least 19 wells within 10 miles of the site producing from 0.01 mgd to 0.1 mgd, 3 wells producing 0.1 mgd to 1.0 mgd, and 2 well fields producing above 1.0 mgd. The two well fields are the Sparrows Point field in Baltimore County and the Glen Burnie field in northern Anne Arundel County (Exhibit 1); respectively, these are approximately 4 and 6 miles from the fill site. There are no additional high capacity wells (1.0 mgd or above) closer to the site.

Only the wells having production above 1.0 mgd were evaluated as being potentially affected or affecting the groundwater movement in and immediately adjacent to the proposed Quarantine Road Secure Landfill. On that basis, the hydrologic conditions of these wells in the Patapsco formation were investigated in two areas: the Glen Burnie well field, and the Sparrows Point well field. This is because the 19 wells producing below 0.1 mgd will have an approximate total average use of 1.0 mgd. Three other wells that average a total use of approximately 1.5 mgd are in the range of 0.1 mgd to 1.0 mgd. A total production of all the 19 wells is well below the daily average production of the Glen Burnie field alone.

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[9] Bennett, Robert R. and Rex R. Meyer, 1952, Geology and Ground-Water Resources of the Baltimore Area, Maryland Geological Survey, Bulletin A, Baltimore, Maryland, 559 pp.

The Glen Burnie field had an actual use of 7.5 mgd between January 1, 1978 and July 1, 1978, with a maximum use of 9.5 mgd on June 25, 1978. The Sparrows Point field used approximately 1.0 mgd during 1977 (the records do not indicate whether these values are average or maximum).

According to a representative of the U.S. Geological Survey, two wells at Sparrows Point are screened in the Patapsco at 206 - 222 feet and 283 - 304 feet. The drawdown on these observation wells is minimal; thus, this well field will not affect or be affected by the fill [10].

There is no recent information or usable observation wells maintained by the Maryland Geological Survey or the U.S. Geological Survey to determine the hydrologic characteristics of the Glen Burnie well field on surrounding wells, especially those between the field and the fill. However, the potential for affecting the Glen Burnie well field will be minimal, because the fill design will contain the operation within a clay horizon that is separated from the lower aquifers by a natural clay barrier.

Conclusions:

The subsurface investigation and evaluation has provided a better understanding of the geologic and hydrologic conditions in the vicinity of the proposed Quarantine Road Secure Landfill. In general, the underlying sediments consist of interbedded clays, silts, and

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[10] Personal communication with Miss Claire Richardson, Geologist, U.S. Geological Survey in Baltimore, Maryland, September, 1978.

sands that have been defined by the boring logs, geologic mapping, and test data.

The so-called "upper clay" is considered the most useful formation for design purposes as it underlies the northwestern, central, and portions of the eastern area of the site. The upper clay is generally absent to the south and southwest, and it is apparently eroded along its eastern limit. The subsurface investigation data indicates that the upper clay can be used as an effective barrier to the potential downward movement of possible fill pollutants.

The deeper "lower clay" surface has been delineated, and it apparently is too deep within the stratigraphic column to be an effective primary barrier to potential pollutants, except where it is contiguous with the upper clay.

The intervening sand and sandy silt materials are expected to be encountered during excavation. The greatest concern is with the sand deposition that appears to be continuous in the southern part of the proposed landfill area outside the limits of the upper and lower clays. wherever the sand and sandy silt sediments are exposed in excavation, the potential for lateral pollutant transmission must be evaluated. If necessary, clay may be transferred from one part of the site to critical areas where an effective clay barrier will be installed.

In general, the sediments have a high clay content wherein the potential for pollutant renovation and attenuation exists despite the limited clay barriers.

The potential for public health hazards related to ground water and domestic water consumption is minimized, because the potential for pollutant renovation and attenuation exists despite the limited clay barriers.

The potential for public health hazards related to ground water and domestic water consumption is minimized, because the potential impact area is served by a central water supply system. Also, the clayey sediments will allow for lateral movement toward the leachate collection system of potential fill pollutants.

The evaluation of existing production well records indicates that the potential for impacting wells within the area is minimal because of the protection offered by the underlying Arundel clay formation and the location of the proposed fill within clay and clayey sediments. Also, the information contained in the State's files and published reports indicates that the drawdown from the production well in the site vicinity will not affect the proposed fill.

In general, the required ground water monitoring wells will detect any potential problems related to the movement of potential pollutants away from the site.

CHAPTER III

SECURE LANDFILL DESIGN RATIONALE

General:

A properly designed and operated secure fill provides an engineered method for the land disposal of solid wastes that minimizes the potential for impact on public health and environmental degradation. In general, the greatest potential for pollution from a secure fill is the possible contact of the wastes or the by-products of decomposing wastes with ground and surface waters. Therefore, a secure fill must minimize the rate of generation of leachate during the waste stabilization period.

When the wastes are deposited in a secure fill, they tend to decompose naturally according to their composition. If the amount of water within the landfill is limited by local climatic conditions or design, the rate of decomposition is generally slow, and the normal by-products of decay are produced gradually. Consequently, the waste stabilization process will occur over a prolonged period of time, and any potential leachate will be gradually released and can be collected and treated.

In order to effectively control the stabilization process, a primary objective of the fill design and operation is to minimize the infiltration of precipitation and increase the rate of surface runoff both during the operation period and after the fill is completed. This will tend to reduce the rate at which leachate is produced, and allow the site's natural geohydrological conditions to control potential adverse effects.

Portions of the Quarantine Road fill site were once acid ponds, used for the uncontrolled dumping of liquid wastes by a previous owner. Consequently, the stabilization process has been accelerated in the older disposal area; and leachate periodically seeps from the fill.

The secure fill design for the continuing fill operation is based on the dry fill concept in order to control its stabilization process and correct an existing environmental problem of many years standing.

Potential for Leachate Generation:

The secure fill is designed to prevent the dumping of wastes into surface water or groundwater, and the design used the existing clay barrier between the base of the new fill and the potentiometric surface and an underdrain system to minimize the effects of potential leachate on the water table. Therefore, the amount of precipitation penetrating the fill directly controls the potential for leachate generation. Additional filling on existing fill areas will be provided with an underdrain system to collect leachate and convey it to on-site treatment.

Any perched water encountered during the excavation will be drained to the water treatment system. Also, the existing natural clays will minimize lateral migration of potential pollutants and will tend to reduce the flow of perched water into the fill.

The basic hydrological principle that exemplifies the relationship between precipitation, evapotranspiration, surface runoff, and infiltration is expressed by the formula:

Net Infiltration = Precipitation - (Runoff + Evapotranspiration)

In order to evaluate the above relationship for a normal fill operation within a specific localized area, the "water balance", as recommended by the U.S. Environmental Protection Agency, has been computed for the proposed Quarantine Road Secure Landfill. [3,4,5]

The water balance method is an engineering technique that takes the total estimated precipitation and subtracts the amount lost due to surface runoff and evapotranspiration to obtain the estimated amount of net infiltration. The gradual additions of yearly infiltration will eventually result in the fill reaching its field capacity, at which time the potential leachate will migrate through the fill and eventually flow into the leachate collection system. When field capacity is eventually reached, the amount of net infiltration will equal the amount of potential leachate that may be available for migration away from the fill.

The actual water balance computation, along with its supporting data is included in the Appendix of this report. The computation indicates that the estimated amount of net infiltration or percolation may equal approximately 3.1 inches per year. This results in the following

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3 Use of the Water Blance Method for Predicting Leachate Generation from Solid Waste Disposal Sites, by Dennis G. Fenn, Keith J. Hanley, Truett V. DeGeare, U.S. EPA, 1975.

4 Thornthwaite, C.W. and J.R. Mather. The Water Balance, Centerton, N.J., 1955, 104 p. (Drexel Institute of Technology, Laboratory of Technology. Publications Climatology, V. 8, No. 1).

5 Thornthwaite, C.W. and J.R. Mather. Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance. Centerton, N.J., 1957, (Drexel Inst. of Tech., Lab. of Tech., Public in Climatology, V.10, No. 3)

data for this site:

GIVEN:

Normal Precipitation	@	40.9 inches/year
Surface Runoff Coefficient	@	.30 (Runoff = 12.3 inches/year)
Evapotranspiration	@	25.5 inches/year

THEREFORE:

Annual Net Infiltration = Precipitation - (Runoff + Evapotranspiration)

3.1 inches = 40.9 inches - (12.3 in. + 25.5 in.)

The total area of the proposed secure fill is approximately 50 acres. Therefore, at the rate of 3.1 inches per year, approximately 4.49 million gallons of water will infiltrate the fill annually. When the fill reaches its field capacity, this volume represents the approximate amount of leachate that will be controlled annually.

Leachate Control:

The precipitation that infiltrates the top of the fill and percolates downward will eventually produce leachate. When leachate reaches the base of the fill, the majority of the leachate volume will tend to flow toward an underlying leachate collection system.

In general, the permeability of the fill is greater than the permeability of the natural, in-place sediment. The permeability of the landfill is approximately 10^{-3}cm./sec. to 10^{-4} cm./sec. which, by comparison, is similar to sand mixtures. This permeability is considered normal for industrial waste fills.

During the site investigation phase, field permeability tests were performed in the site's sediments. The tests in the upper clay resulted in values within the 10^{-6} cm/sec. range which is typical for moderately impermeable clay according to the Unified Soil Classification System. One test in the sand resulted in a k value of 3 x 10^{-4}cm./sec. which is characteristic of a silty sand.

In order to minimize the amount of potential downward leachate percolation below the fill in the area of excavation in original ground, a clay barrier having a permeability within the 10^{-6}cm./sec. range will be provided by either leaving the natural, upper clay in place for a minimum depth of 3 feet below the excavation grade; or by placing the on-site excavated clay where required on the excavated side slopes or in the bottom of the excavation to seal the more permeable sandy sediments and to minimize potential pollutant migration away from the new fill area.

For design purposes, the permeability of the clay barrier is considered to be within the 10^{-6} cm./sec. range. Field testing during the initial and continuing site preparation phases of the operation will be required to confirm that the permeability of the clay barrier is within the 10^{-6} cm./sec. range.

A system of underdrains is proposed to intercept and divert leachate from the fill area to the leachate treatment system. In areas I and II, the underdrain system will be placed on top of the clay barrier, while in area III, the drains will be placed on top of a layer of gypsum. The layout of the drain system is shown in the attached drawings. Design criteria for the underdrain system is given in Appendix D.

The purpose of the underdrain system is to collect and divert the leachate from the fill area to the leachate treatment system. The underdrain system will insure that the water level will be at the level of the proposed tiles in Area III. The selected drainage coefficient (0.3 in./hr.) will insure that the system will be able to handle infiltration from high intensity short duration storms. Therefore, it is expected that little or no leachate will penetrate lower stratas.

On areas of the fill which have been previously filled, a base will be constructed, using by-product gypsum, to establish a sloping grade toward the center of the site. An underdrain system, similar to that used in the excavated undisturbed area, will be provided in the gypsum buffer under the proposed new filling to collect the leachate from this portion of the site and convey it to collection and treatment.

Monitoring Program:

The effectiveness of the fill operation will be continually evaluated by means of the monitoring program. The program will include establishing groundwater and surface water monitoring points approved by the State.

Groundwater observation wells will be installed for the collection of groundwater samples from the secure fill vicinity. The sediment control basin will provide an additional location where surface water runoff samples can be collected. Additional surface water sampling points will be established for routine monitoring of the streams in the vicinity of the fill. Background sampling will be performed by the appropriate regulatory agencies as soon as the wells are installed to establish the monitoring program. Local industrial wells could be monitored periodically to provide data on general quality of the water in the deeper aquifers underlying the site.

CHAPTER IV

ENGINEERING AND DESIGN

General:

The Quarantine Road Secure Landfill is designed to maximize the use of the site for manufacturing by-product waste disposal. In general, the site will be operated as a modern secure type fill, using the area fill method for solid wastes.

The engineering design is based on the results of the subsurface investigation and the basic design rationale which has been discussed in preceding chapters of this report.

This chapter discusses the general waste and cover characteristics which together provide the estimated fill life. Also, the methods for controlling potential leachate quantities are discussed, as well as the erosion and sediment control plan.

Solid Waste Characteristics:

The proposed Quarantine Road Secure Landfill will serve the Chemical/ Metallurgical Division of SCM.

Approximately 50 tons of DHS waste and 1112 tons of other process waste and by-product gypsum will be received daily. The hazardous substances will generally consist of acids, inorganic sludge, mixed chemical sludge, inorganic solids, and mixed chemical solids. Additional grading for surface water control will be provided by filling with non-hazardous gypsum by-product waste from the SCM plant.

Cover Material Characteristics:

The Excavation Plan provides for approximately 437,000 cubic yards of material which consists of sandy, silty and clayey sediments. Due to the method of excavation and stockpiling, the excavated materials will be adequately separated prior to its application as either barrier material or earth cover.

The subsurface investigation revealed that a substantial clay zone underlies the majority of the SCM tract wherein the new excavation-fill will be operated. Of the total excavation volume, approximately 40,000 cubic yards of clay is estimated to be available for the placement of approximately 12,000 cubic yards required for the 2-foot clay barrier in areas of the new excavation not sealed by undisturbed clay, leaving a theoretical clay surplus of approximately 28,000 cubic yards.

The remaining excavated material, which consists of approximately 397,000 cubic yards, will be used for the daily and final earth cover. The estimated cover requirement is approximately 779,000 cubic yards. Therefore, approximately 354,000 cubic yards of cover represent the quantity to be provided by use of the by-product gypsum. Excavated clean earth will be stockpiled for use as final cover for the fill.

Projected Fill Life:

The Final Grading Plan is designed to maximize the site's usage for solid waste fill. The fill will be graded to provide that all water falling on the filled area will be directed toward the sediment control and/or treatment collection system.

The estimated total secure fill volume is approximately 3,116,000 cubic yards of combined DHS and gypsum.

Based on the reported waste densities, the proposed fill will provide disposal for approximately 2,574,000 tons of DHS and gypsum. At the estimated annual production of approximately 362,500 tons of DHS and gypsum per year, the fill would serve approximately 7.1 years. If gypsum recycling occurs, the fill life could be extended, depending on the recycling rate, to as long as approximately 17.5 years.

Leachate Control:

The secure fill design incorporates a combination of the site's natural geohydrological conditions and an engineered system to provide collection and treatment of potential pollutants which emanate from the fill during the waste stabilization period.

Leachate collection is provided by two methods in order to control the potential amount that may emanate from the fill.

In general, an underdrain system will be constructed under the fill to collect leachate emanating from under the fill. The underdrain system will channel the leachate to the collection sump by gravity and then be pumped to treatment. In addition, a surface runoff collection system will be installed, as required, in order to channel potentially contaminated surface runoff into the leachate collection system. If, in the future, the fill has stabilized to the point where the surface runoff fraction is no longer contaminated, it will be allowed to bypass the treatment system in accordance with the appropriate regulatory agency approvals, and in accordance with the NPDES permit limitations.

As discussed in "Chapter III; Secure Landfill Design Rationale", it has been estimated that essentially all of the potential leachate, from the planned additional filling, will be collected in the subsurface system and be channeled to the leachate treatment system. However, any remaining leachate which bypasses the underdrain system will percolate into the clay barrier where natural renovation mechanisms will tend to attenuate the pollutants in this minute quantity.

The underlying clay barrier of the newly excavated fill area has been designed to provide a minimum 2-foot thickness of either in-situ clay or installed clay from the on-site excavation. Its design permeability will be within the 10^{-6} cm./sec. range in order to provide the permeability differential to effect subsurface leachate runoff. The graded and compacted gypsum base for the continuing fill area is expected to have a permeability in the 10^{-4} cm./sec. range.

Erosion and Sediment Control:

The sedimentation and erosion control provisions shown on the attached drawings are designed to meet the requirements of Baltimore City.

The detailed design provides for the construction of the necessary diversion ditches, disturbed area stabilization and sediment basin as one of the first tasks during the initial site preparation. In this way, the continuing site preparation and the extended fill operation will have minimal impact on the natural drainage ways in the vicinity. All disturbed areas will be properly seeded and stabilized according to the procedures listed on the drawings.

The sediment control plan is based on the concept of channeling surface runoff to the perimeter ditch system and through the sediment basin. The final grading plan provides for an estimated runoff coefficient of .30 to allow about 30% of the precipitation to flow over and away from the completed portions of the fill, in order to minimize infiltration into the fill. The sediment control plan is designed to handle the flow expected during a 10-year storm, in accordance with the Soil Conservation Service requirements.

When an area is completed and properly stabilized, the need for sediment control is minimal. However, the ditches and leachate control system will be maintained for the life of the facility as a further control measure to protect receiving waters from possible contamination.

Monitoring:

The secure fill design drawings show the locations of groundwater and surface water monitoring points suggested for on-site monitoring of the operation by the appropriate state regulatory agency. The design of a typical groundwater monitoring well is included on the attached drawings.

Regular monitoring of the wells is expected to indicate the performance of the secure fill and determine the potential for off-site effects prior to their occurrence. Also, the surface water discharge point should be monitored to determine compliance with the limitations set by the NPDES permit.

CHAPTER V

OPERATING PROCEDURES

General:

The Quarantine Road Secure Landfill is designed as a basic, area-type fill. The fill will have grades, when completed, to promote surface runoff.

Supervision:

In order for the fill to operate efficiently, it is necessary that the fill supervisor understand the operating plan and see that it is diligently adhered to. The supervisor must continually plan each day's operation and insist that the tasks are accomplished on a daily basis, regardless of the circumstances, in order to prevent deterioration of the operation and its costly correction.

In addition to the placing and covering of the waste received each day, the supervisor must plan the continuing site preparation with the on-site equipment and manpower; maintain the access roads, sediment control facilities and completed fill areas; plan for equipment servicing; stockpile cover material for daily cover, final cover and completion grading; plan for an orderly progression of filling; and maintain basic records of site completion, types and quantities of waste filled in specific areas, equipment maintenance and operating expenses.

Initial Site Preparation:

The fill design allows for the gradual extension of the fill operation into remaining portions of the site. In general, the initial site preparation will consist of constructing the drainage diversion ditches and sedimentation controls; the initial portion of the leachate collection system; the leachate treatment system; and the monitoring controls.

The secure fill operation will extend northward across the SCM tract. Therefore, the initial excavation area must be borrowed from in order to provide the clay for the clay barrier in the new fill area; to provide the final earth cover; and to provide room for the continuing fill.

By excavating to the attached excavation grading plan, the perched water within the sediments will be drained to a low point and diverted away from the fill operation. The clay barrier will be placed where required along the sides of the excavation to seal further perched water drainage, and to prevent lateral movement of potential pollutants from the new fill area.

After the clay barrier is installed in the new fill area, it will be tested to prove that its permeability is within the 10^{-6} cm./sec. range or lower.

Groundwater monitoring wells for the site will be installed, and any well points located within the future fill area will be removed and properly sealed before the placement of wastes.

Continuing Site Preparation;

Continuing site preparation for the next operating area will be required before the initial operating area reaches final grade. The seeding of completed areas, periodic cleaning of the sediment basin, and construction of the temporary haul roads are all tasks included in the continuing site preparation work. Excavation of the next area should begin in accordance with the progression of the fill and the depletion of the cover material stockpile. When the next area is excavated or graded, it will be prepared and tested in a similar fashion as the initial trench and the underdrain are installed.

Also, the initial excavation area will be opened. In this way, the fill operation can be extended as required for its useable life.

Detailed Operation:

Trucks arriving at the fill site will be directed to the working face of the fill by proper signs. Upon arriving at the active area of the fill, the driver will deposit his load at the base of the working face, where directed by the fill foreman. After depositing the load, the driver will immediately proceed from the fill.

When the waste has been deposited, and the truck has moved from the site, the equipment operator will proceed to spread the waste up the working face. This procedure will continue until the final load of waste has been placed, at which time the operator will begin to spread the daily cover of by-product gypsum.

During the initial portion of the operating day, the cover material operation will begin, and the cover will be stockpiled close enough to the working face to allow it to be spread. Upon completion of the daily stockpiling of cover material, the equipment and operator become available to perform the other tasks required in either fill maintenance, completion or continuing site preparation. An option available to the fill supervisor is to continue the stockpiling of cover for two to three days at a time, to minimize bad weather cover material transport or to allow the equipment and operator to be available for two to three days for the other tasks previously mentioned.

On-site road maintenance will be performed on an as-required basis, using the equipment assigned to the fill.

Sediment basin cleaning will be performed as required.

Placement of Cover:

Cover will be either stockpiled by-product gypsum or excavated from the areas shown on the Excavation Plan. Usually, the cover will be stockpiled near the active fill area during the day, with the last few loads spread directly on the waste. The Excavation Plan shows the limits of the excavation areas. The thickness of the compacted daily cover will be a minimum of six inches. Excavated material will be stockpiled for final fill cover.

The thickness of the final earth cover will be a minimum 2-feet applied as the final lift is placed in an area of the completed fill. Completed areas will be stabilized in accordance with the U.S. Soil Conservation Service requirements.

Inclement Weather:

The secure fill has been designed as an all-weather operation to minimize the area required to be disturbed at any given time and maintain a reasonable filling sequence. The grading plans are designed to provide adequate surface drainage, both during and after construction of the fill. Properly stabilized haul roads will adequately support vehicular traffic under most operating conditions. During extreme conditions of freezing and thawing, or extended periods of rainfall, the use of additional gravel, crushed stone or rubble will be required to maintain the on-site access roads. A stockpile of masonry rubble, broken concrete (without reinforcing steel), broken paving and similar items may be developed at the site, for this purpose.

Field Engineering:

A system of vertical and horizontal controls will be installed at the fill, for use in laying out site preparation construction, fill area location, excavation grades and final fill grades. While intermediate fill heights can usually be judged by eye by the supervisor, the final fill elevations must be surveyed to maintain the proper final fill grades to allow maximum disposal of wastes and minimize wasting of cover material in establishing the completed fill elevation.

Periodic checks on elevations and horizontal alignment are as necessary as the initial stake-out on a properly operated secure fill.

Site Completion:

Upon completion of the placement of the final cover to the finished grades shown on the drawings, the soil will be tested and up to 2,000 pounds per acre of ground dolemite limestone, as required, will be applied. The limestone will be worked in the top 3-inches of soil, by discing or harrowing, and the surface will be fine graded.

Seed fertilizer and mulch will be applied in the Spring, between March 15 and May 30; or in the Fall, between August 15 and November 15; and other times when conditions are suitable. No seeding will be performed when weather conditions such as drought, high winds, excessive moisture or other factors would prevent the establishment of a satisfactory stand of grass.

In general, the rate of application will be a mixture of Kentucky 31 Tall Fescue at 120 lbs/acre, and Innoculated Sericea Lespedeza at 20 lbs/acre. However, the drainage ditches will be seeded with Kentucky 31 Tall

Fescue only. Any exceptionally wet areas will be seeded with Reed Canary grass at the rate of 10 lbs/acre.

Eroded areas will be repaired and reseeded, as necessary, until a satisfactory covering of grass is established.

CHAPTER VI

EQUIPMENT AND MANPOWER

General:

The equipment and manpower required to operate the secure fill, are dependent upon the type and quantity of waste received for disposal, the operating plan, basic site maintenance requirements, and the actual effective equipment operating time. In addition, basic stand-by equipment must be available on short notice to allow the fill to continue operating during periods of equipment break-down or extended maintenance.

Manpower requirements are dependent on the equipment used and the basic plan of operation of the fill. Provisions must be made to cover periods of absence caused by illness and vacation in order to maintain the daily efficiency of the operation.

Adequate equipment and manpower, working at the site with proper supervision during all periods of the operation, are the two most important items in maintaining the daily operating efficiency required at a proper secure fill.

Equipment:

In general, the daily fill requirements and the continuing site preparation are the most equipment-intensive operation. Although the final equipment selection may be modified as operating experience is gained, the following equipment is considered to be necessary, initially.

Daily Fill Operation:

Quantity	Equipment Item	Function
1	crawler loader or bulldozer	Spread waste and cover

Excavation-Fill Area Preparation (Part-time — As Required):

1	crawler loader or bulldozer	Stockpile cover and excavate excavate material
1	sheeps foot roller (Part-time)	Compact gypsum or clay barrier

Periodically, additional equipment will be required to perform the necessary site preparation and maintenance. This equipment may be provided on either a rental basis or the work can be performed by contract.

Manpower:

An adequate fill staff will be required on a permanent basis to operate and maintain the Quarantine Road Secure Landfill. When required, additional manpower will be provided by temporary employment for special clean-up projects , seasonal seeding and fill area preparation.

The following table is a list of the suggested full-time personnel that may be required at the fill:

Position	Duty	Quantity
Supervisory Person - Treatment System Operator	Responsible for overall execution of the fill plan & direct the daily operation; operate & inspect the leachate control system	1
Heavy Equipment Operator	Operate all types of fill equipment	2*

*as required by operation.

The other normal operating duties such as equipment maintenance and special tasks will be performed, as required, by additional personnel, as the operation indicates their need.

CHAPTER VII

GENERAL FILL MANAGEMENT

General Facilities:

The basic facilities required to provide secure fill management and to meet State standards will be provided for the Quarantine Road fill. In general, they include the controlled receiving area, the access and haul road network, the drainage and sediment controls, the subsurface leachate collection system, the leachate treatment system, the monitoring system, and personnel facilities.

The entrance to the site is located on Quarantine Road. The fill will be controlled by security guards or locked gates, during non-operation hours, to prevent unauthorized use of the site. A permanent, all-weather access road has been constructed to serve the receiving area and provide efficient traffic circulation.

A trailer will be located as shown on the drawings, and will be provided with telephone, electric lights, heat, ventilation, potable water, and a toilet facility for the operating personnel.

Water supply will be provided by connection to the Baltimore City Central system. Sewerage for the trailer will be provided by an approved septic tank system or holding facility.

Site Access and Signs:

Site access and traffic flow will be controlled by one-way ingress and egress from Quarantine Road. The remoteness of the operating area within the site, and the buffer provided by the B & O Railroad and the Interstate 695 will generally control unauthorized site access. As deemed necessary, measures will be initiated to control access to the operating area and the site facilities.

On-site signs will be provided as necessary, to direct the delivery vehicles to the working area of the fill and stipulate conditions of use.

An all-weather access road from Quarantine Road to the fill area will be maintained. Temporary on-site haul roads will be constructed as required, to maintain truck access to the progressing working areas.

Communications:

Telephone communication will be provided at the trailer for off-site communication.

Dust Control:

The remoteness of the operating area will normally minimize the occurrence of off-site dust nuisances. On-site dust will be controlled by the application of water to the access roads.

The establishment of vegetative cover on completed areas will minimize the potential for dust nuisances.

Drainage and Sedimentation Control:

The drainage and sedimentation control facilities designed for the site are intended to provide drainage both during the site preparation and after the site has been completed. As previously set forth, it is necessary that these facilities be maintained throughout the life of the operation. Care must be exercised in planning the progressive filling of the site to assure that rainfall is diverted away from the waste.

The sediment control plan has been designed according to the requirements of the U.S. Soil Conservation Service and Baltimore City.

Supervision and Safety:

The operating procedures outlined in this report are intended to provide an environmentally safe, nuisance-free secure fill, meeting the requirements of the State of Maryland. The daily supervision will be performed by the full-time Superintendent. In addition to the responsibility for the general fill operating efficiency, the Superintendent will be responsible for seeing that safe operation practices are followed by both the operating personnel and the drivers of the delivery vehicles.

In the event of accident or personal injury, the emergency procedure developed by the fill Superintendent will be followed.

Records:

Basic records will be kept as part of the routine secure fill operation. These records consist of areas filled, dates during which they were filled, quantities and types of wastes received, equipment maintenance, and any special occurrences during the fill operating period. A set of the secure fill plans will be marked to record the progress of the continuing site preparation, earth cover excavation, seeding and stabilization, and the fill operation. Also, periodic monitoring and site inspection visits, as well as local individual complaints will be recorded to indicate the degree of operating efficiency. Manifests will be maintained, as required, for DHS waste.

Hours of Operation:

The normal operating hours of the Quarantine Road Secure Landfill will be from 7:30 A.M. to 4:00 P.M., Monday through Saturday.

This schedule, essentially, provides ample time during daylight hours to spread and cover the waste, with care being required to begin covering before the closing hours. It also provides some time within the normal working day to maintain the fill site and perform continuing site preparation tasks, as previously set forth.

Inspection:

The inspection and evaluation of the secure fill operation is a function of the regulatory agency at the state level. Access to the site for purposes of inspection will be made to all authorized personnel at any time during normal operating hours.

In addition, the fill superintendent will conduct his own periodic inspections to determine the efficiency of his operation and general compliance with the operating plan.

Leachate Management:

As set forth in previous chapters of this report, any potential leachate will be controlled by a system of subsurface underdrains and a surface collection system that channel their respective flows to the leachate collection system for treatment.

APPENDICIES

A - Boring Logs & Laboratory Data; Atec Associates of Maryland, Inc.

B - Miscellaneous Subsurface Investigation Data

C - Production Well Data

D - Design Rationale Computation and Water Balance Computation Instructions

E - Design Drawings and Geologic Maps

APPENDIX A

BORING LOGS & LABORATORY DATA PREPARED BY

ATEC ASSOCIATES, INC. OF MARYLAND

QUARANTINE ROAD SANITARY LANDFILL

BALTIMORE, MARYLAND

ATEC JOB NUMBER: D-78256-B

ATEC

Atec Associates®

American Testing & Engineering Corporation and Subsidiaries

APPENDIX

1. Summary of Laboratory Test Data
2. Gradation Curves
3. X-Ray Diffraction Results
4. Cation Exchange Capacity Results
5. Test Boring Logs
6. Unified Soil Classification Sheet
7. Field Classification Sheet

Project:

ATEC Job No.: D-78256-B

SUMMARY OF LABORATORY TEST RESULTS

Boring No	Sample No	Sample Depth feet	Sieve Analysis*	Hydrometer Analysis*	Natural Moisture Content%	Natural Dry Density lbs/cu ft	Limits, % L.L.	P.L.	P.I.	pH	Specific Gravity	Coefficient of Permeability cm/sec	X-Ray Diffraction*	Cation Exchange Capacity *
OW-5	5	23.5-25.0	X	X	19.0		35	20	15	7.2				
OW-5	6	28.5-30.0								6.8			X	X
OW-6	4	18.5-20.0	X	X	16.2		41	17	24	7.7				
OW-6	5	23.5-25.0								7.2			X	X
OW-7	3	13.5-15.0	X	X	17.0		48	25	23	6.9			X	X
OW-7	6A	30.0-32.0	X	X	17.8		non-plastic			7.3		**		
OW-7	9	43.5-45.0	X	X	14.0		19	19	0	6.8				
OW-7	10	48.5-50.0								6.8			X	X
OW-8	3	13.5-15.0	X	X	16.9		non-plastic			7.2				
OW-8	4	18.5-20.0								7.0			X	X
OW-9	5	23.5-25.0	X	X	10.9		non-plastic			7.2				
OW-9	6	28.5-30.0								7.3				X
OW-10	5	23.5-25.0	X	X	11.8		22	18	4	6.6				
OW-10	6	28.5-30.0								6.8				X
OW-10	8	38.5-40.0	X	X	21.4		25	20	5	6.5				
OW-11	4	18.5-20.0	X	X	13.8		24	16	8	8.0				
OW-11	5	23.5-25.0								7.9				X
OW-11	8	38.5-40.0	X	X	18.0		27	23	4	8.0				

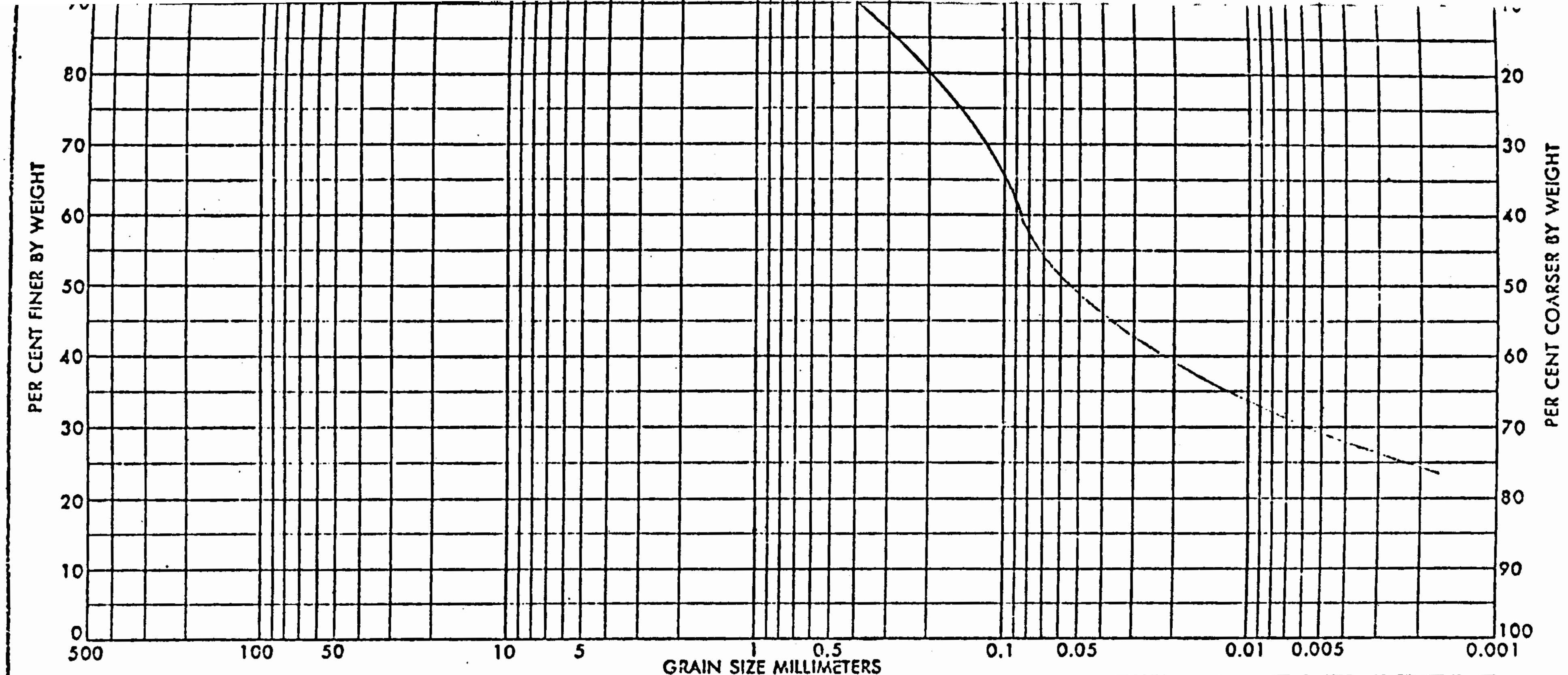
Project: Quarantine Road Landfill

ATEC Job No.: D-78256-B

SUMMARY OF LABORATORY TEST RESULTS

Boring No	Sample No	Sample Depth feet	Sieve Analysis*	Hydrometer Analysis*	Natural Moisture Content%	Natural Dry Density lbs/cu ft	Limits, % L.L.	P.L.	P.I.	pH	Specific Gravity	Coefficient of Permeability cm/sec	X-Ray Diffraction*	Cation Exchange Capacity *
OW-12	5	23.5-25.0	X	X	21.6		32	20	12	7.7				
OW-12	8	38.5-40.0	X	X	19.5		non-plastic			7.7				
OW-13	2	8.5-10.0	X	X	12.9		20	10	10	7.2				
OW-13	5	23.5-25.0	X	X	20.7		42	20	22	6.4				
OW-13	6	28.5-30.0								7.0			X	X
OW-13	6A	30.0-32.0										**		
OW-13	7	33.5-35.0	X	X	22.0		35	22	13	6.8				
OW-13	9	43.5-45.0	X	X	32.8		71	50	21	6.6				

* See separate test result sheet.
** Sample was not suitable for permeability testing.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
2	8.5-10.0	Reddish Brown Clayey fine SAND (SC)	12.9	20	10	10

PROJECT	Quarantine Road Landfill
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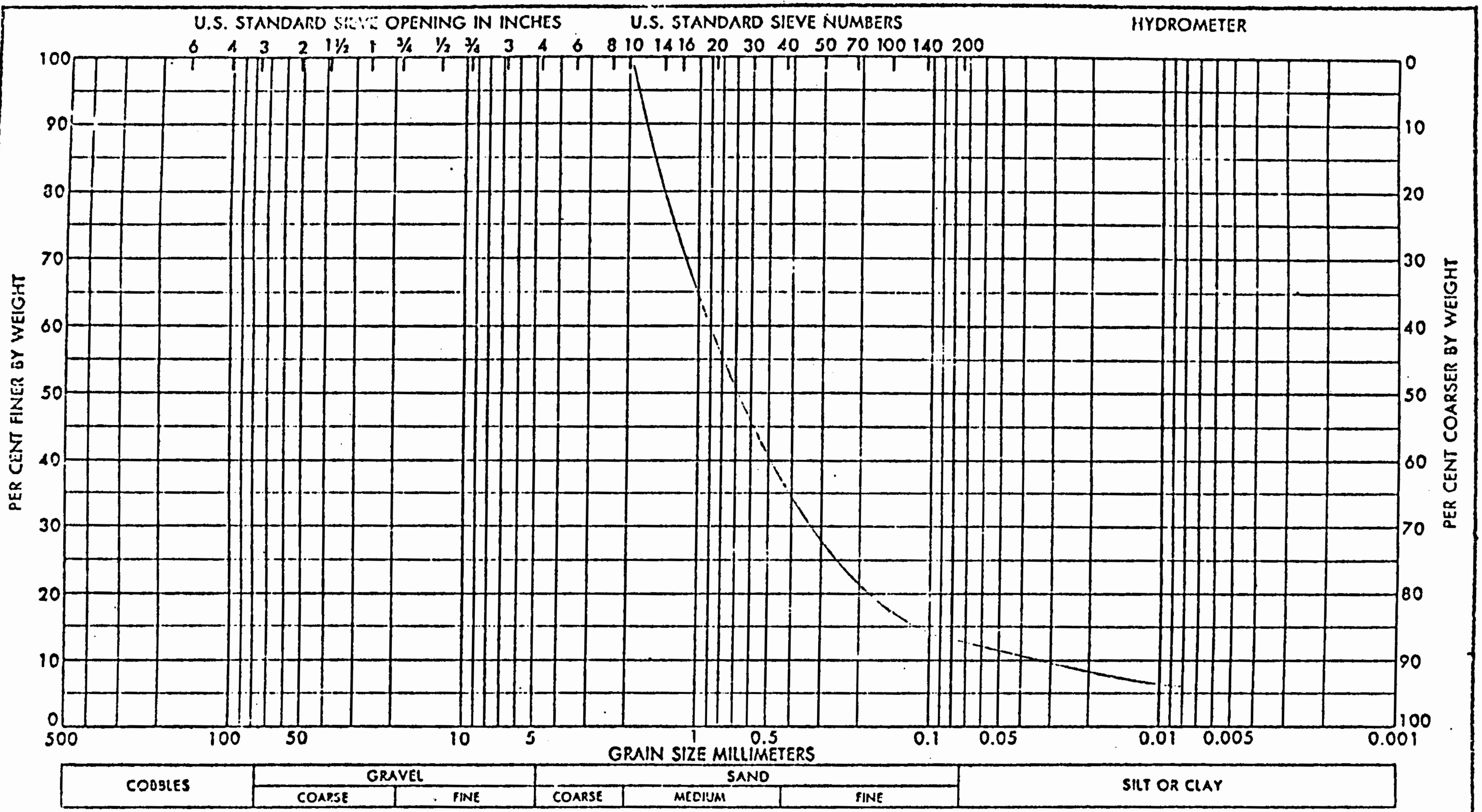
AREA	
BORING NO.	13
DATE	7/20/78

GRADATION CURVES



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8	38.5-40.0	Grey medium SAND (SP)	19.5	-	-	-

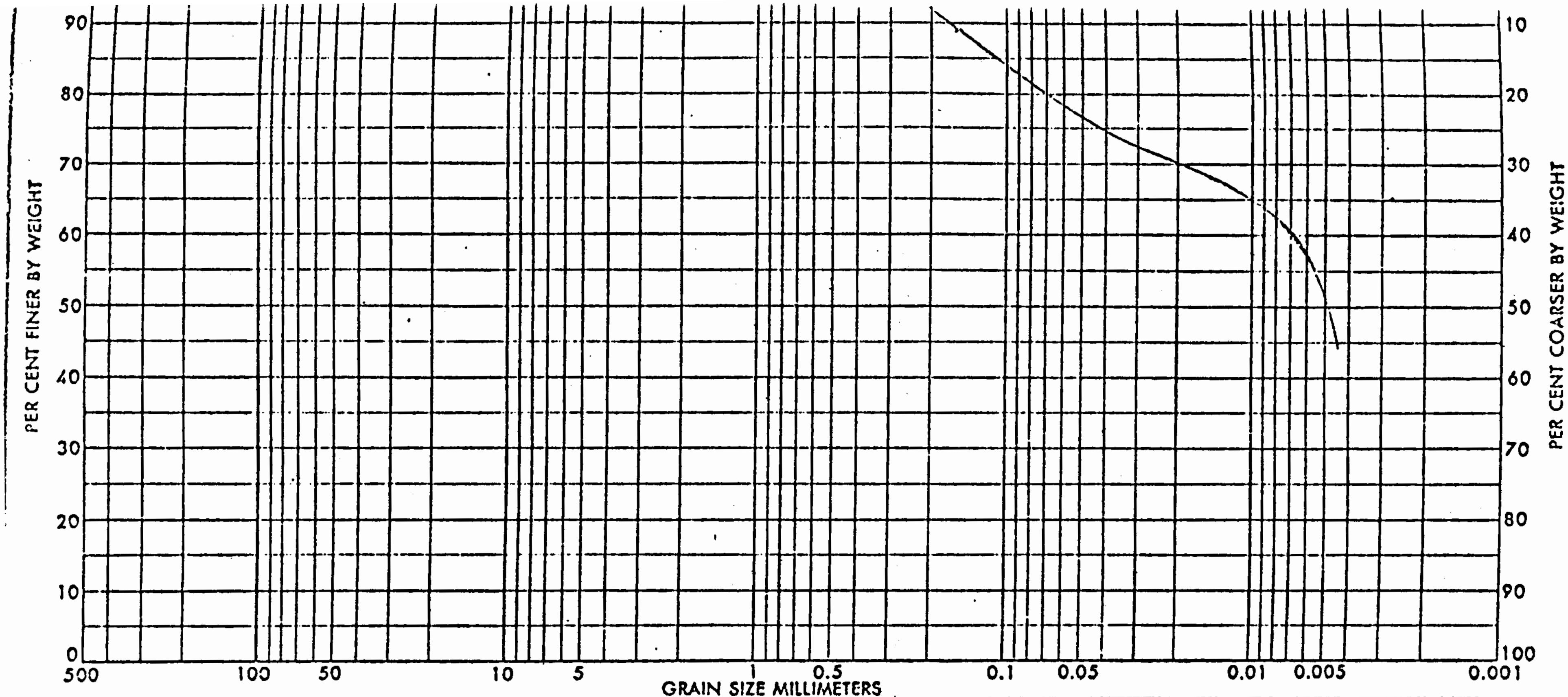
PROJECT Quarantine Road Landfill
E-78256

AREA

BORING NO. 12

DATE 7/20/78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	23.5-25.0	Reddish Brown , grey and tan Silty CLAY(CL)	21.6	32	20	12

PROJECT Quarantine Road Landfill
E-78256

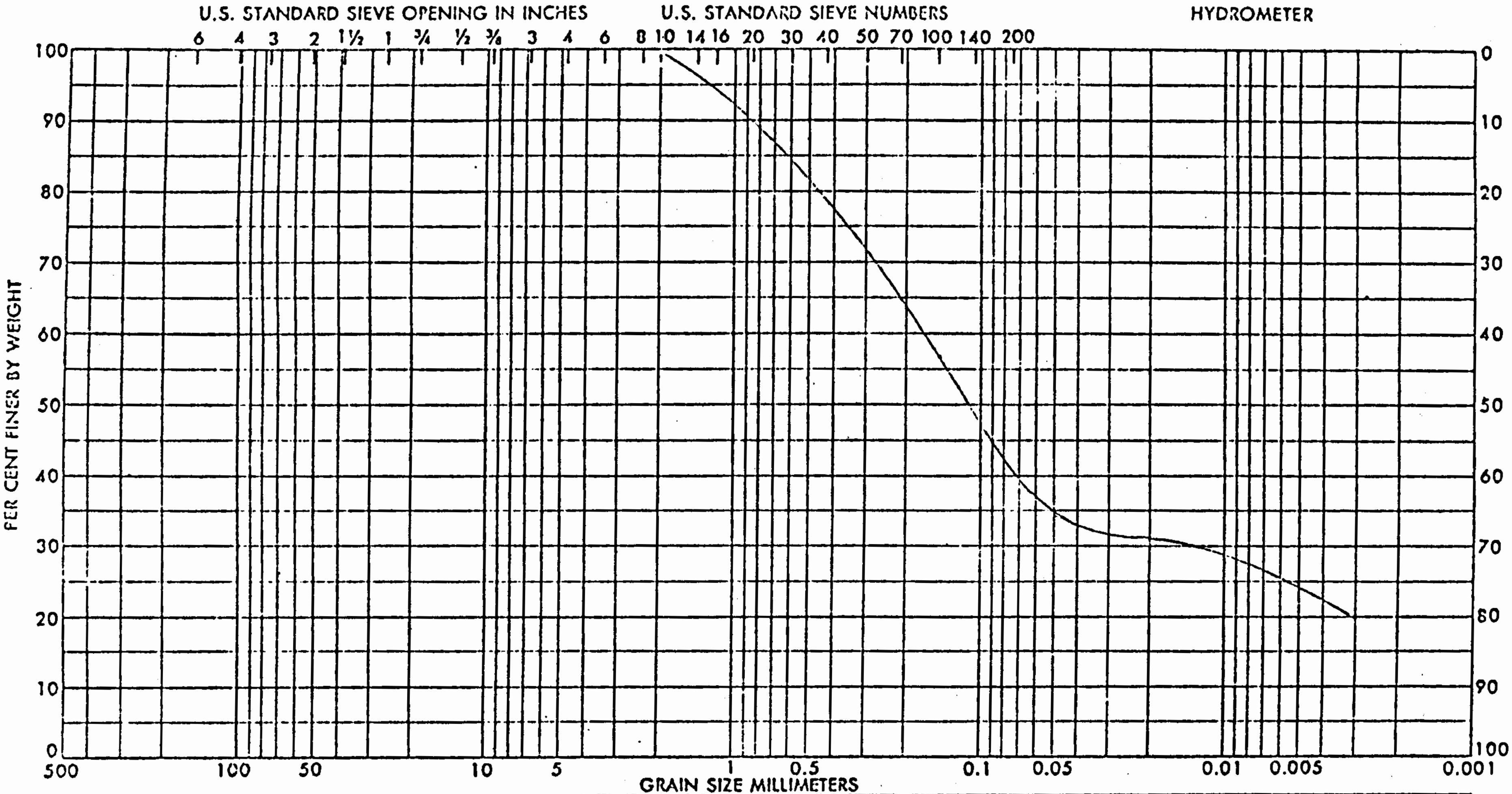
AREA

BORING NO. 12

DATE 7/20/78

GRADATION CURVES

FORM 105



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8	38.5-40.0	Brown to Reddish Brown Clayey fine SAND (SC)	18.0	27	23	4

PROJECT Quarantine Road Landfill

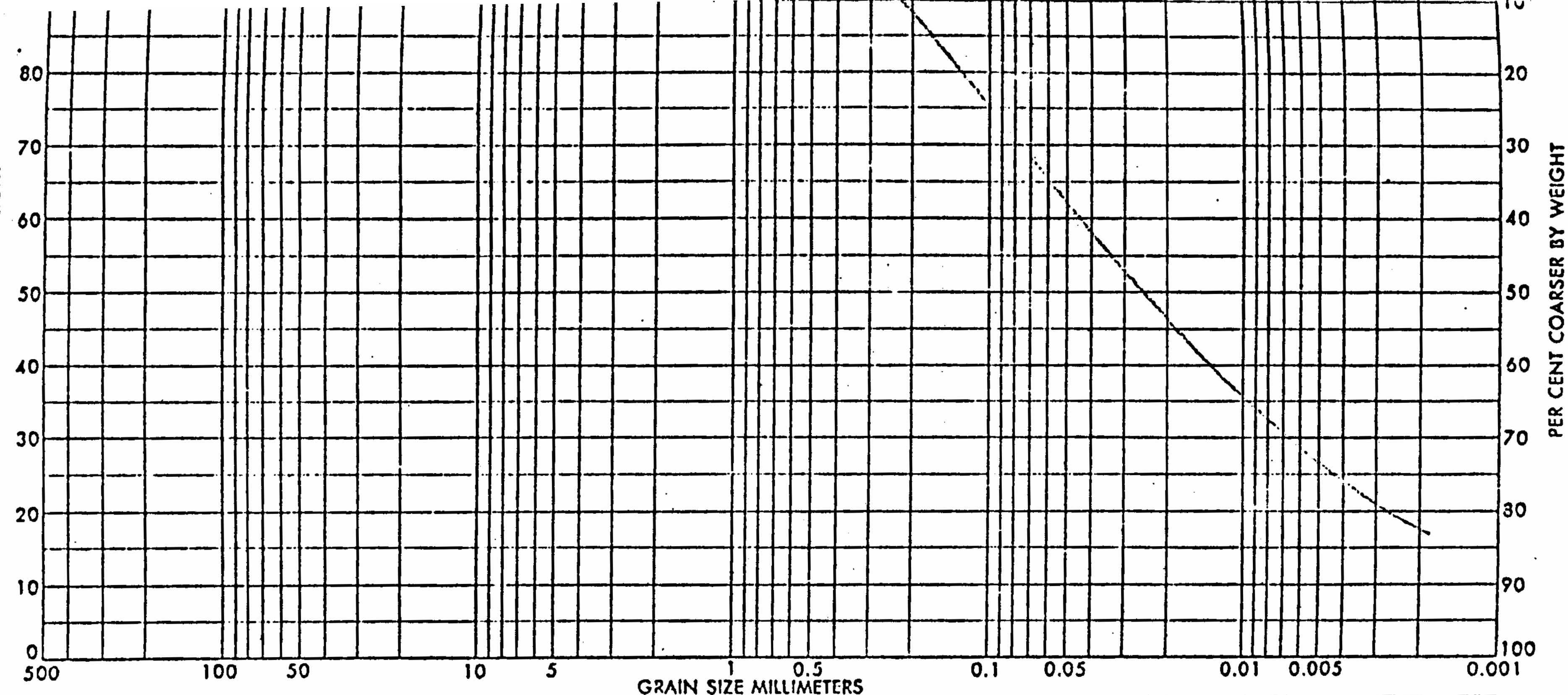
E-78256

AREA

BORING NO. 11

DATE 7/20/78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	18.5-20.0	Tan and grey Silty CLAY (CL)	13.8	24	16	8

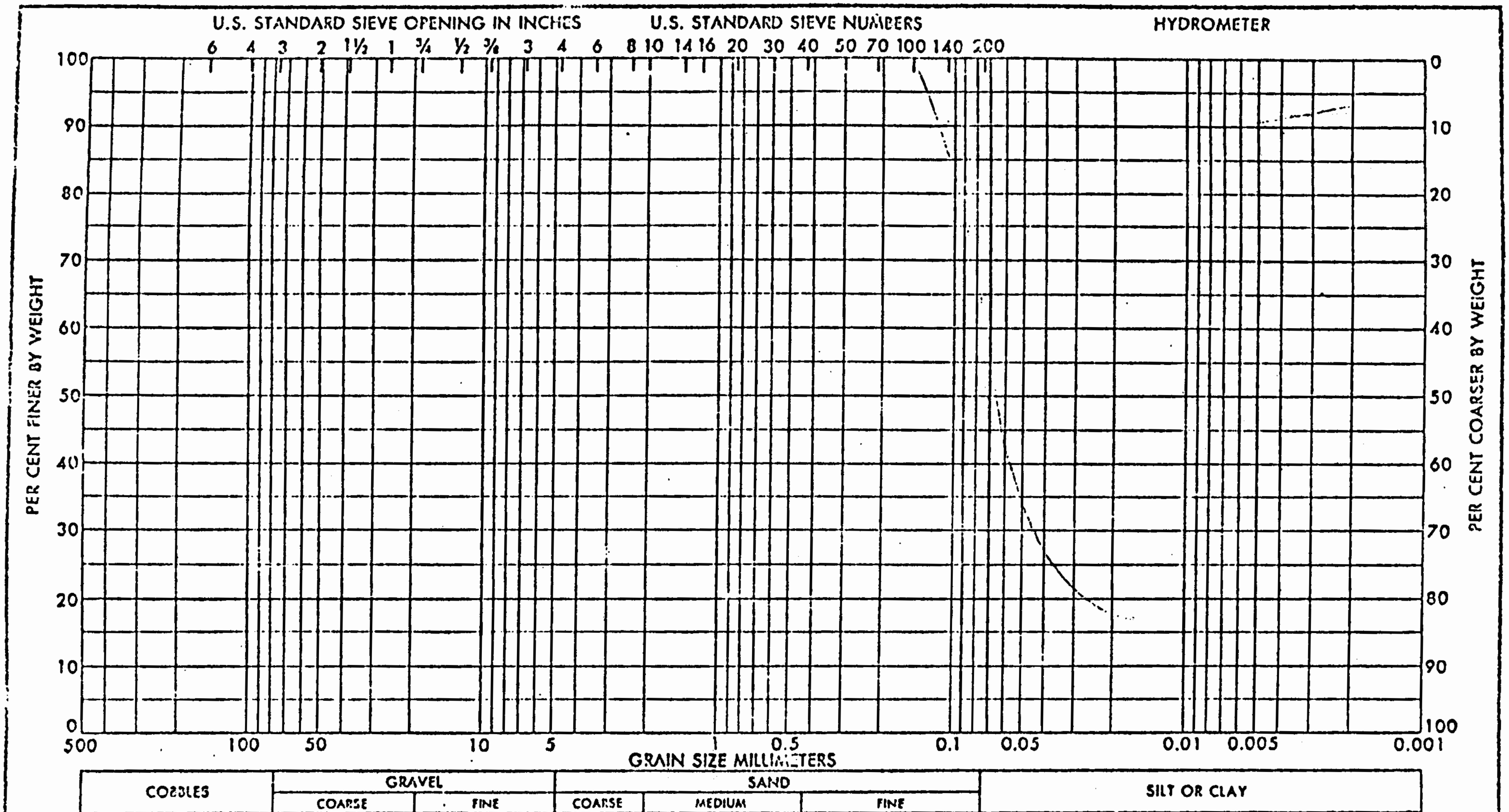
PROJECT Quarantine Road Landfill
E-78256

AREA

BORING NO. 11

DATE 7/20/78

GRADATION CURVES



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8	38.5-40.0	CL-ML	21.4	25	20	5

GRADATION CURVES

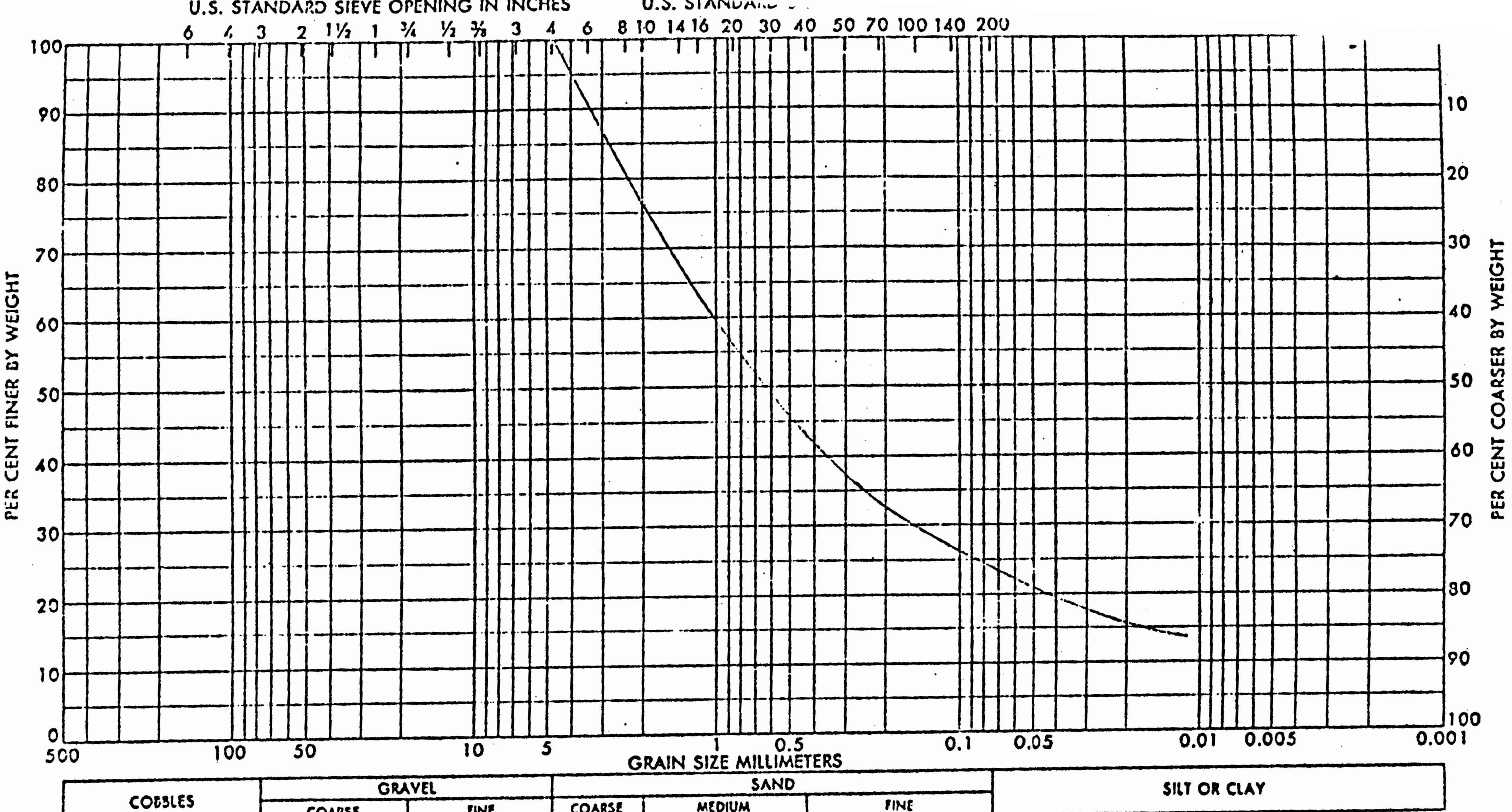
PROJECT Quarantine Road Landfill

D 78256-B

AREA

BORING NO. 10

DATE 8/1/78



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	23.5-25.0	SM	11.8	22	18	4

PROJECT Quarantine Road Landfill

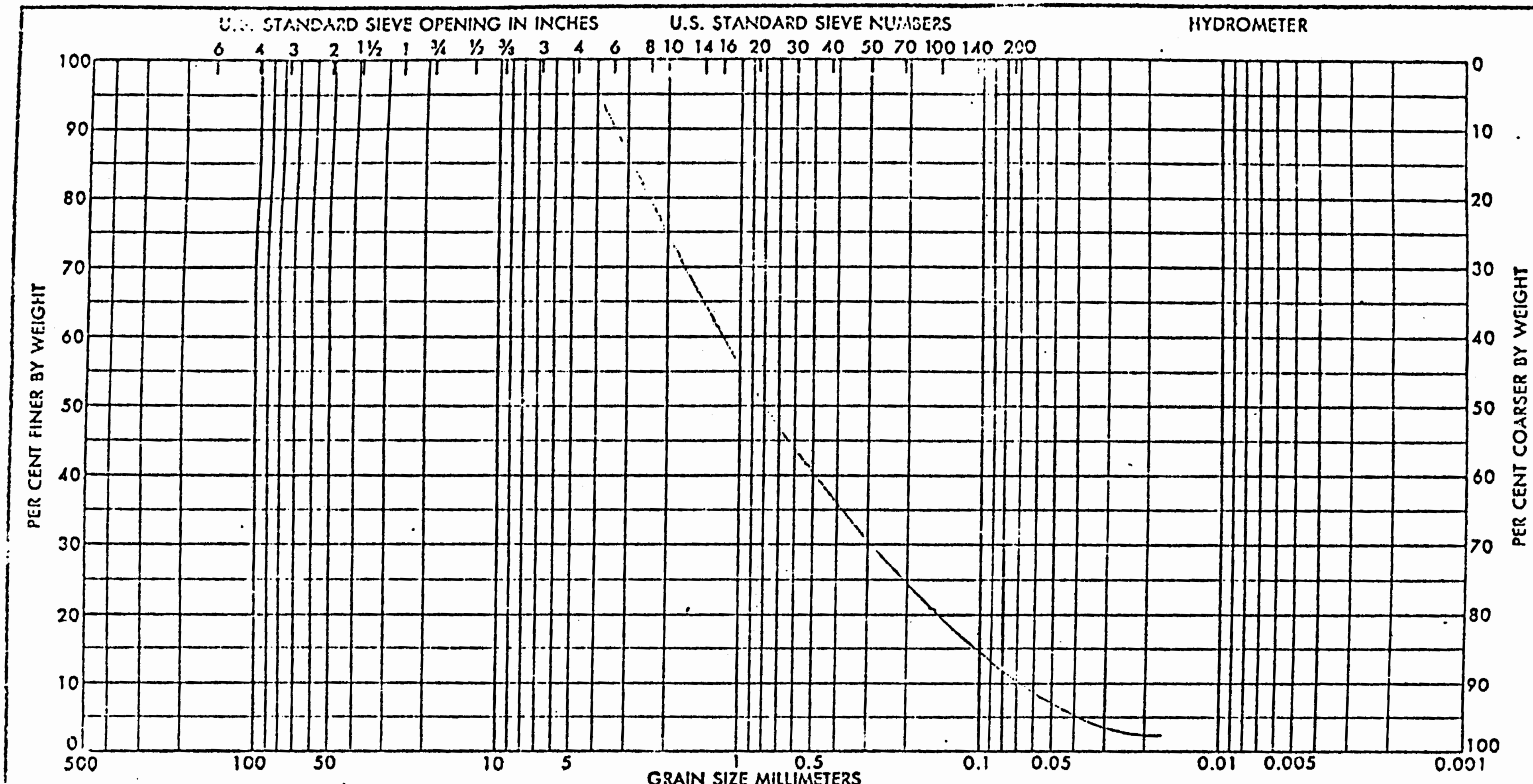
D 78256-B

AREA 10

BORING NO.

DATE 7/20/78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	23.5-25.0	Light tan and grey Silty SAND (SM)	10.9	–	–	–

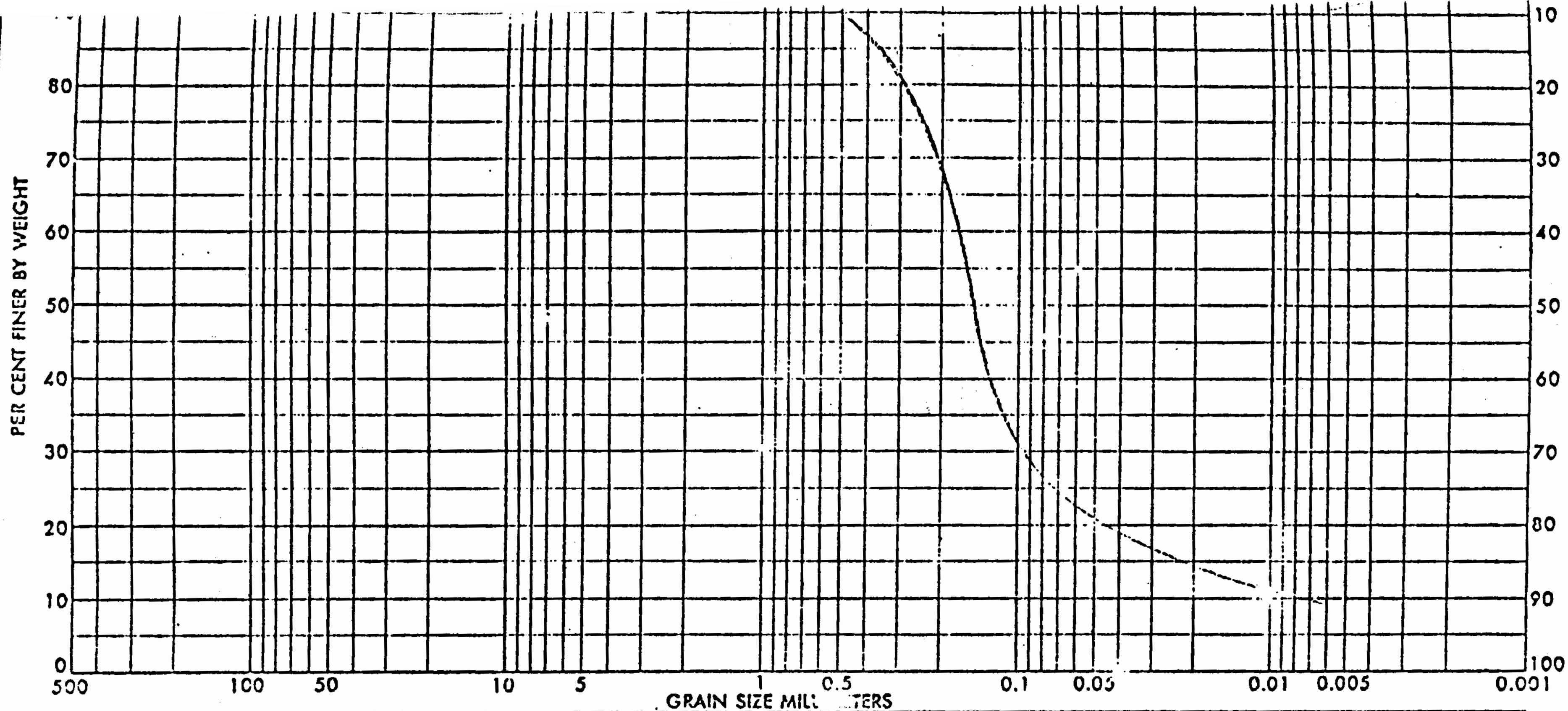
PROJECT Quarantine Road Landfill
E-78256

AREA

BORING NO. 9

DATE 7/20/78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	13.5 - 15.0	SM	16.9	non-plastic		

PROJECT Quarantine Road Landfill

D-78256-B

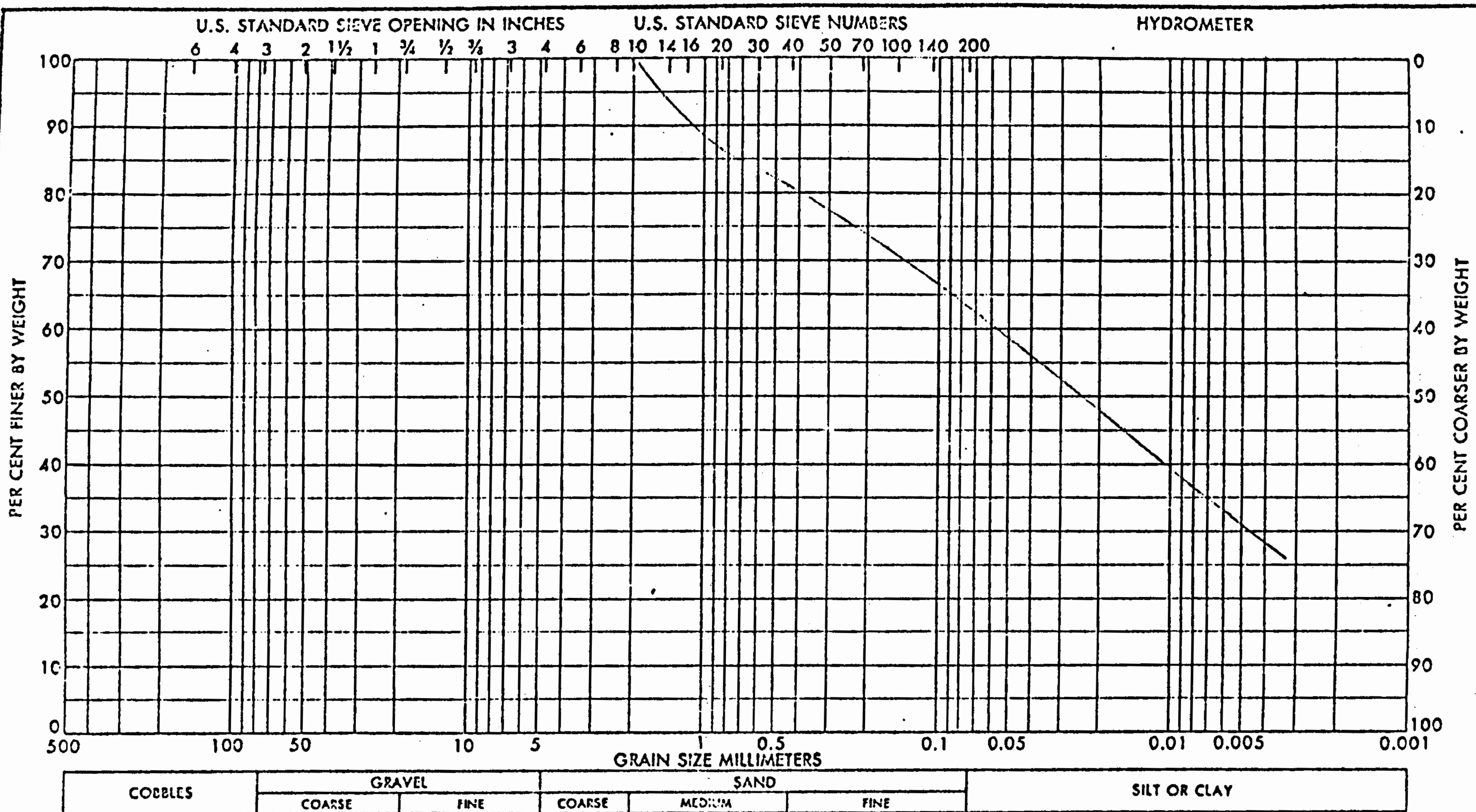
AREA

BORING NO. 8

DATE 8/1/78

GRADATION CURVES

FRM 105



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
9	43.5-45.0	Light grey and Tan Clay and SAND (ML)	14.0	19	19	0

PROJECT Quarantine Road Landfill

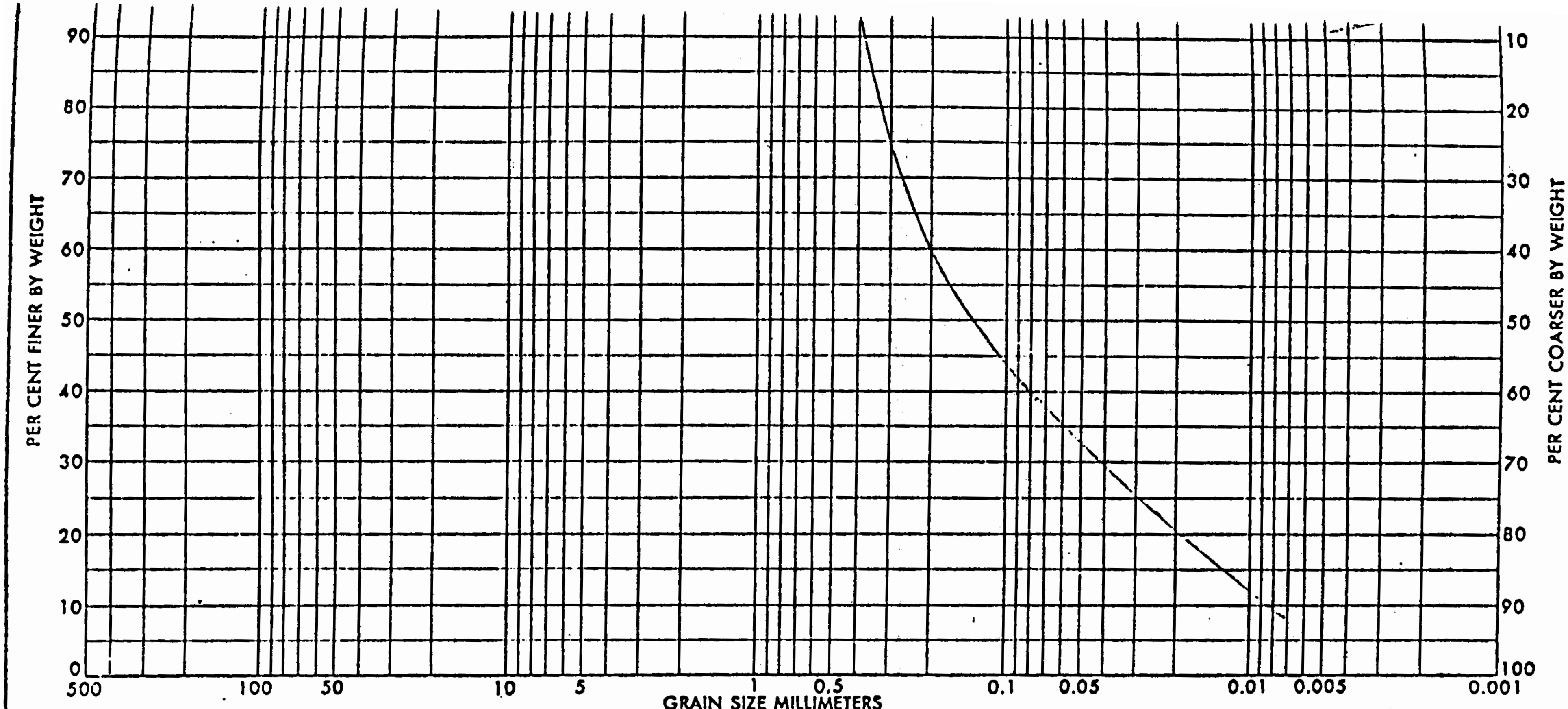
E-78256

AREA

BORING NO. 7

DATE 7/20/78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
6A	30-32	SM	17.8	NP	-	-

GRADATION CURVES

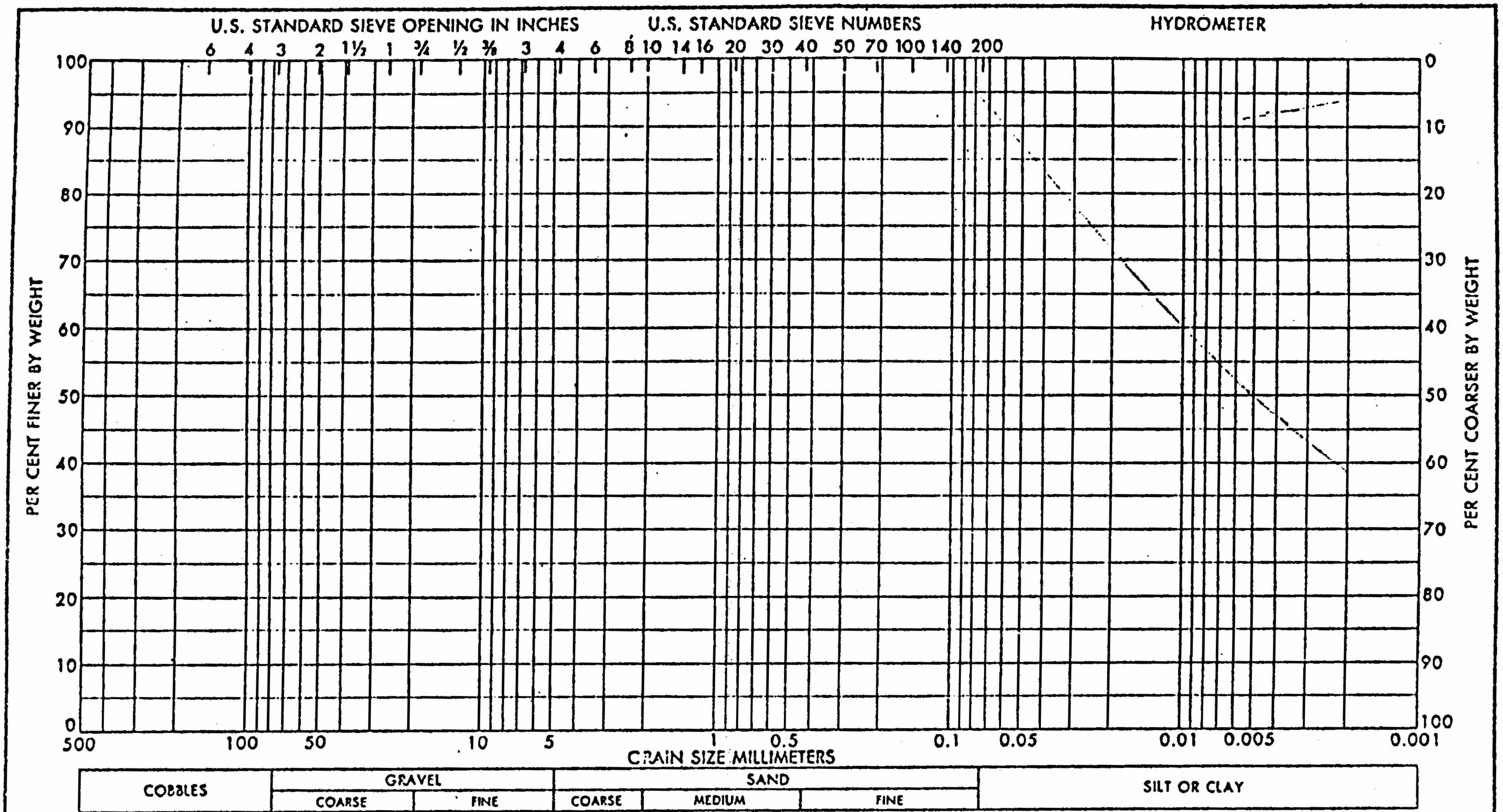
PROJECT Quarantine Road Landfill

E-78256

AREA

BORING NO. 7

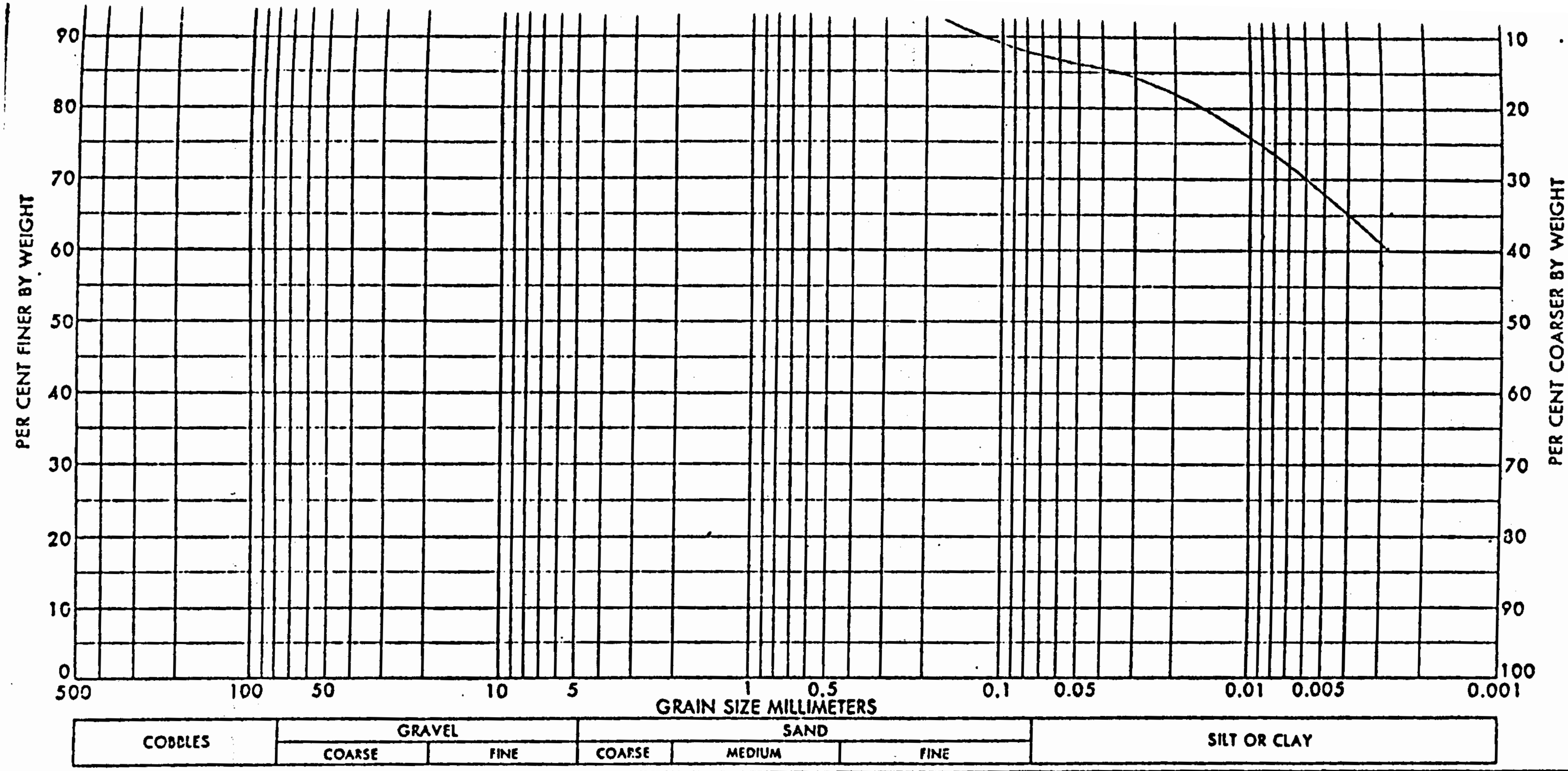
DATE 7/20/78



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
3	13.5-15.0	Mottled Reddish Brown, tan and grey Silty CLAY (CL)	17.0	48	25	23

PROJECT	Quarantine Road Landfill
	E-78256
AREA	
BORING NO.	7
DATE	7/20/78

GRADATION CURVES



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4	18.5-20.0	Reddish Brown, tan and grey Silty CLAY (CL).	16.2	41	17	24

GRADATION CURVES

PROJECT Quarantine Road Landfill

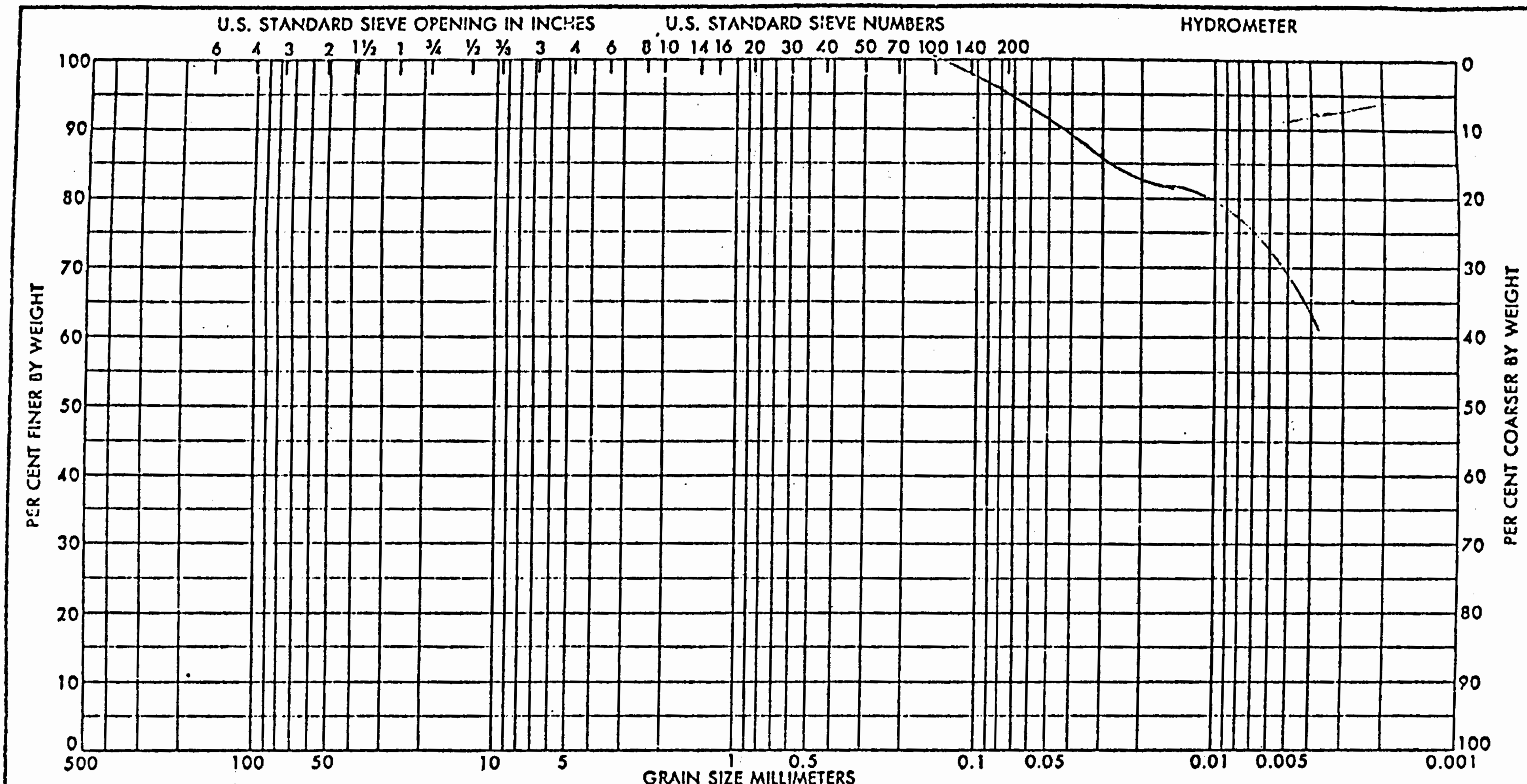
F-78256

AREA

BORING NO. 6

DATE 7/20/78

ORM 105



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	23.5-25.0	Reddish Brown, grey and tan Silty CLAY (CL)	19.0	35	20	15

PROJECT Quarantine Road Landfill

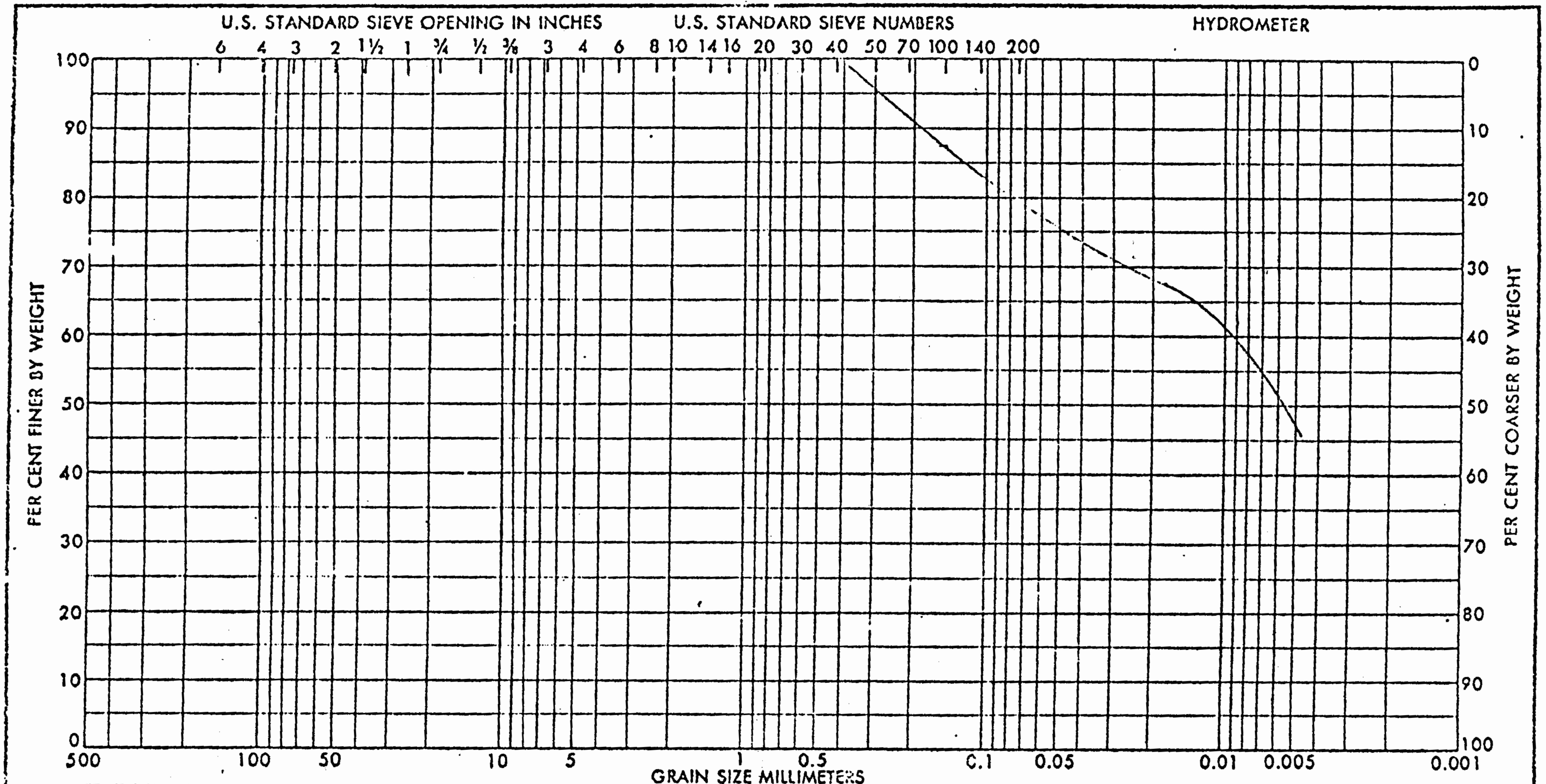
E-78256

AREA

BORING NO. 5

DATE 7/20/78

GRADATION CURVES

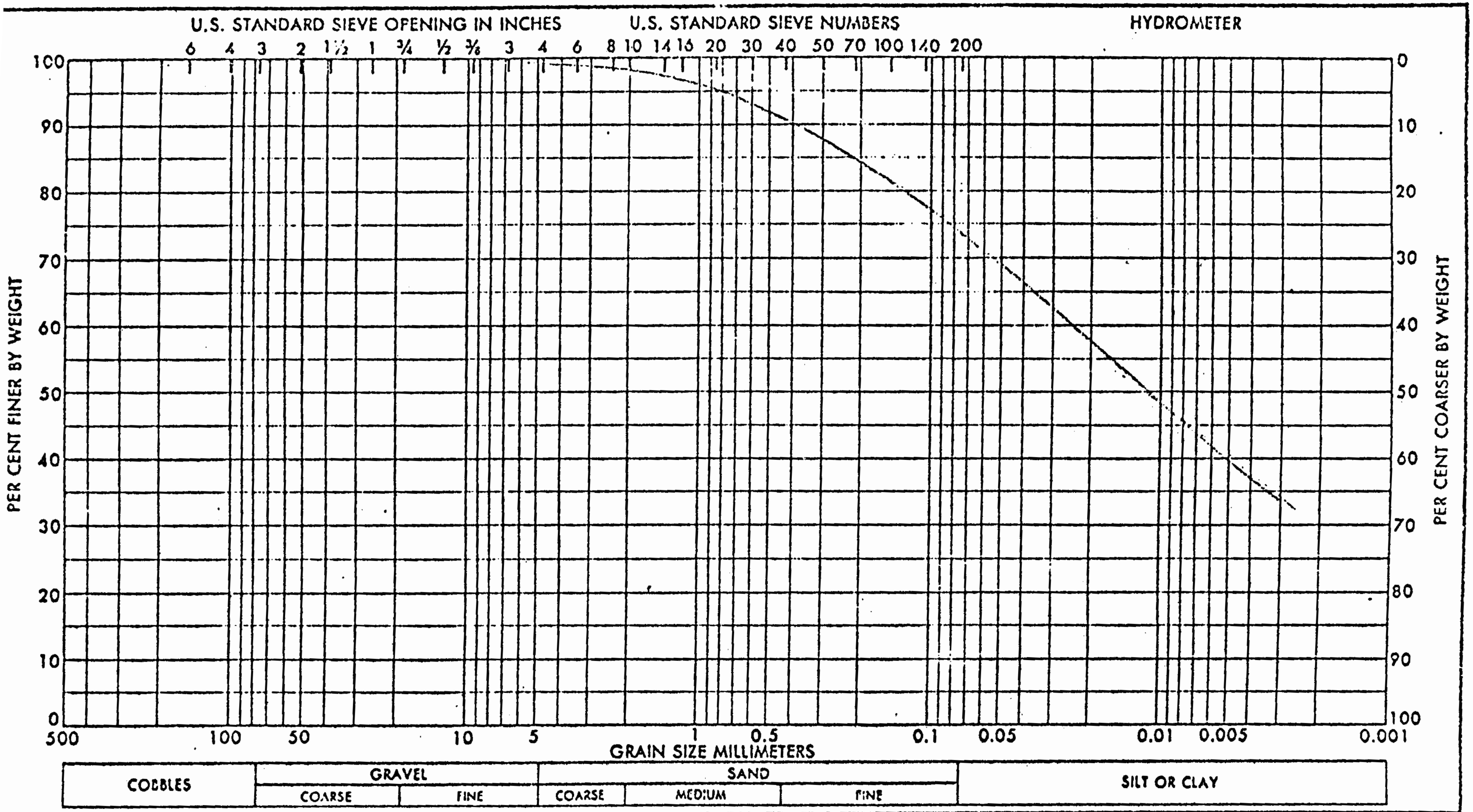


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
5	43.5-45.0	Mottled Reddish Brown, Tan and grey Silty CLAY (CL)	20.7	42	20	22

PROJECT	Quarantine Road Landfill E-78256
AREA	
BORING NO.	13
DATE	7/20/78

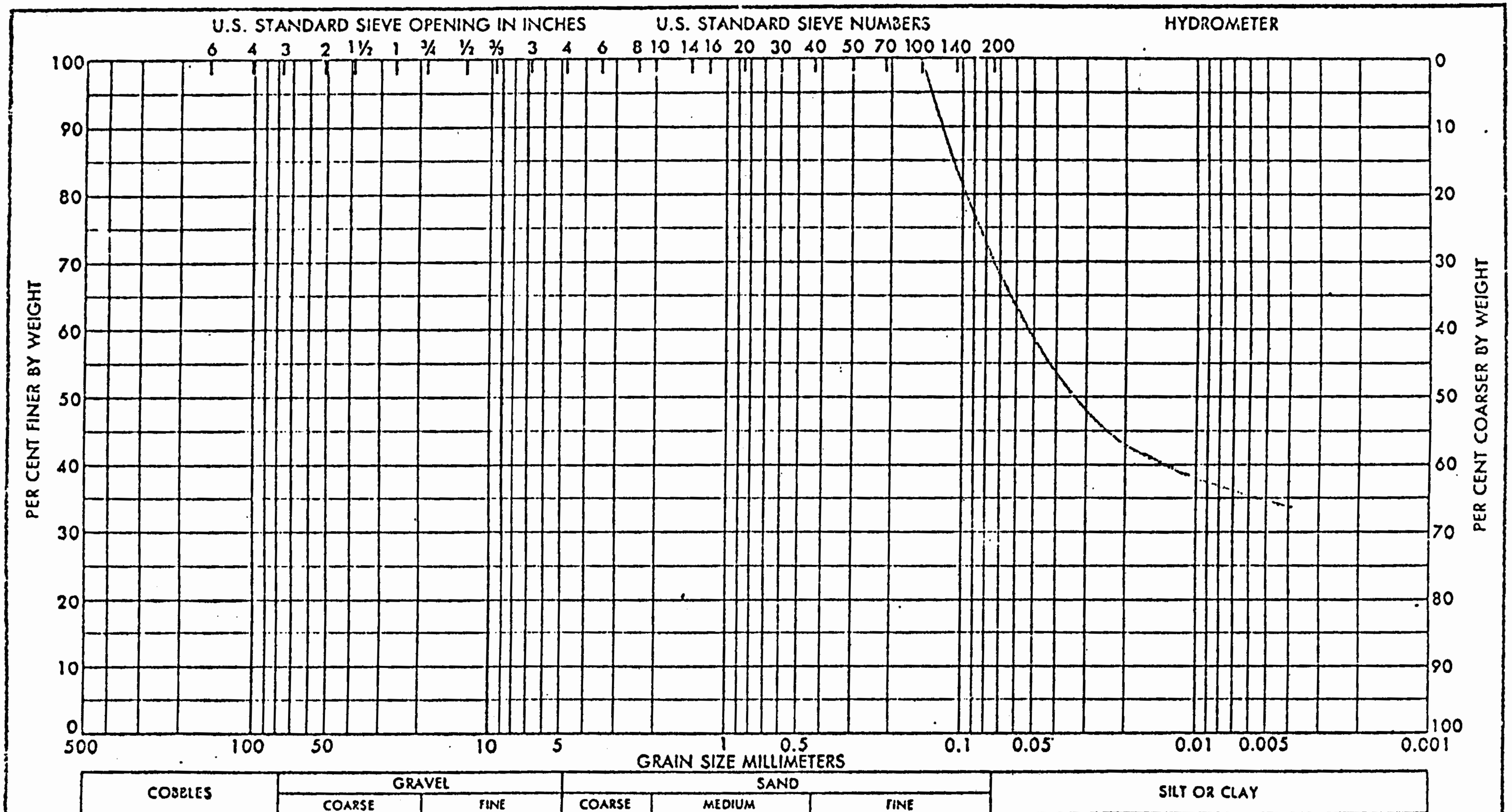
GRADATION CURVES



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
7	33.5 - 35.0	CL	22.0	35	22	13

PROJECT	Quarantine Road Landfill
	D-78256-B
AREA	
BORING NO.	13
DATE	8/1/78

GRADATION CURVES



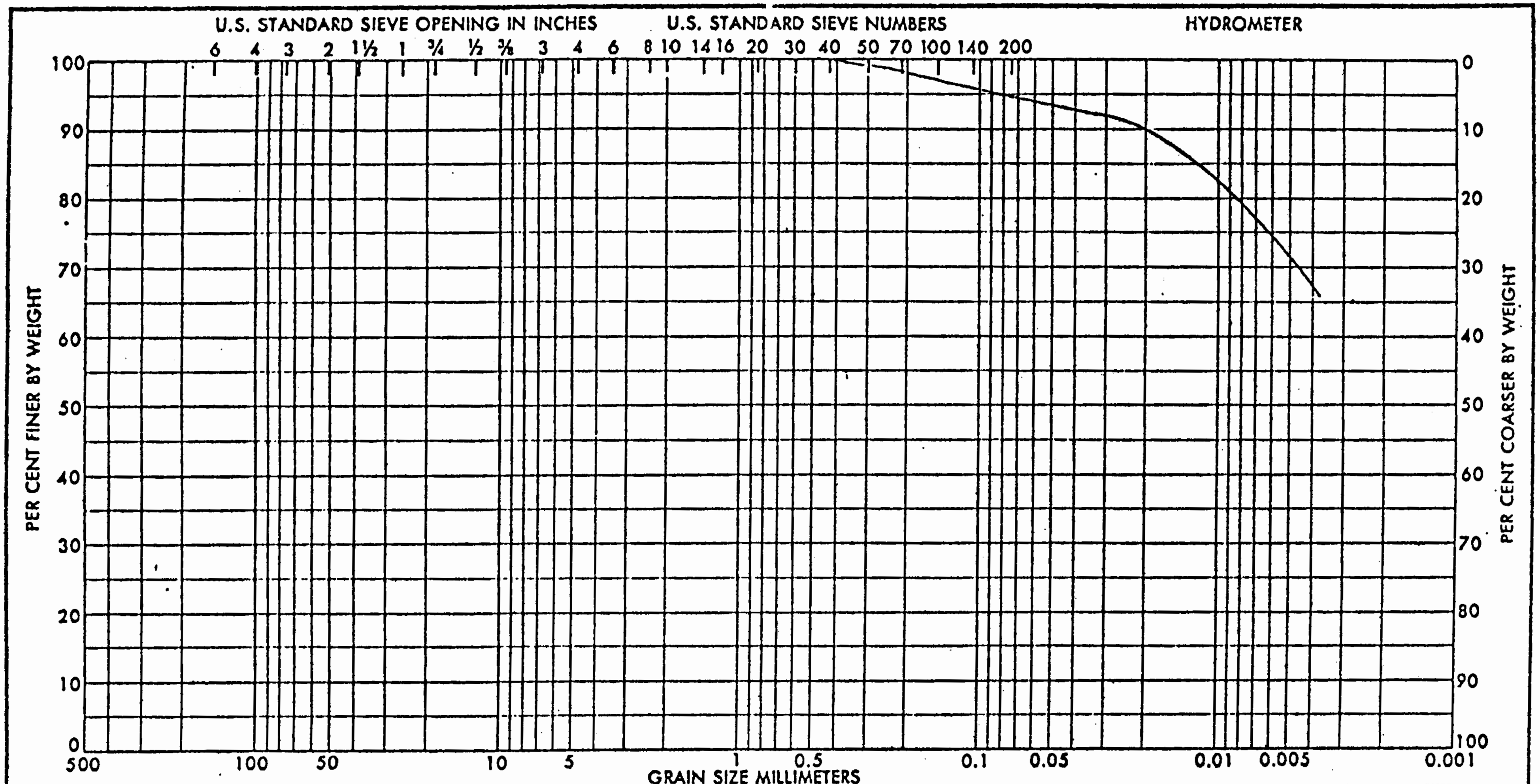
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
9	43.5-45.0	Mottled Reddish Brown, tan and grey Silty CLAY (CL)	32.8	71	50	21

PROJECT Quarantine Road Landfill

E-78256

AREA

BORING NO. 13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4		CL		46	26	20

PROJECT Quarantine Fill

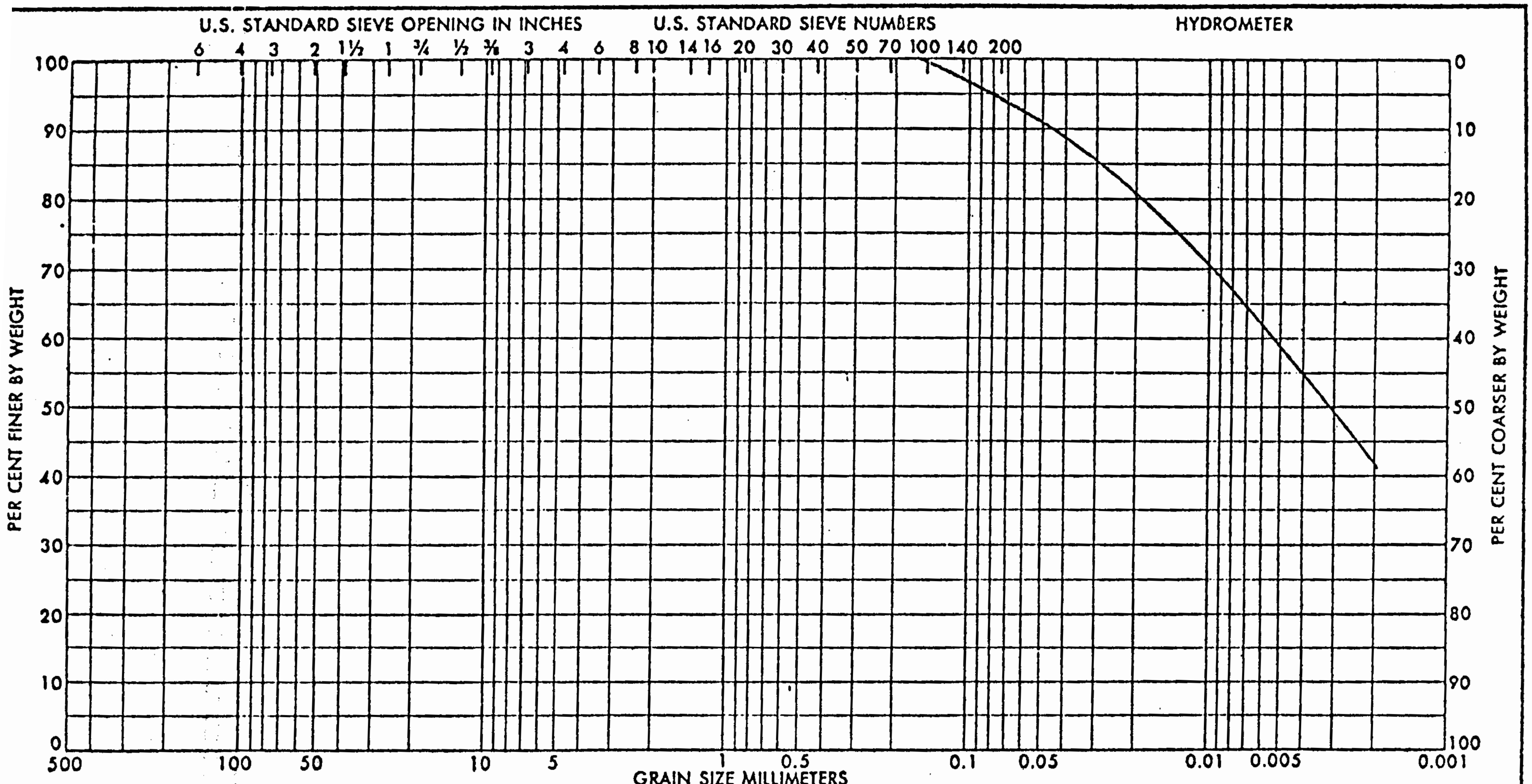
D-78256-B

AREA

BORING NO. 14

DATE 9-15-78

GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

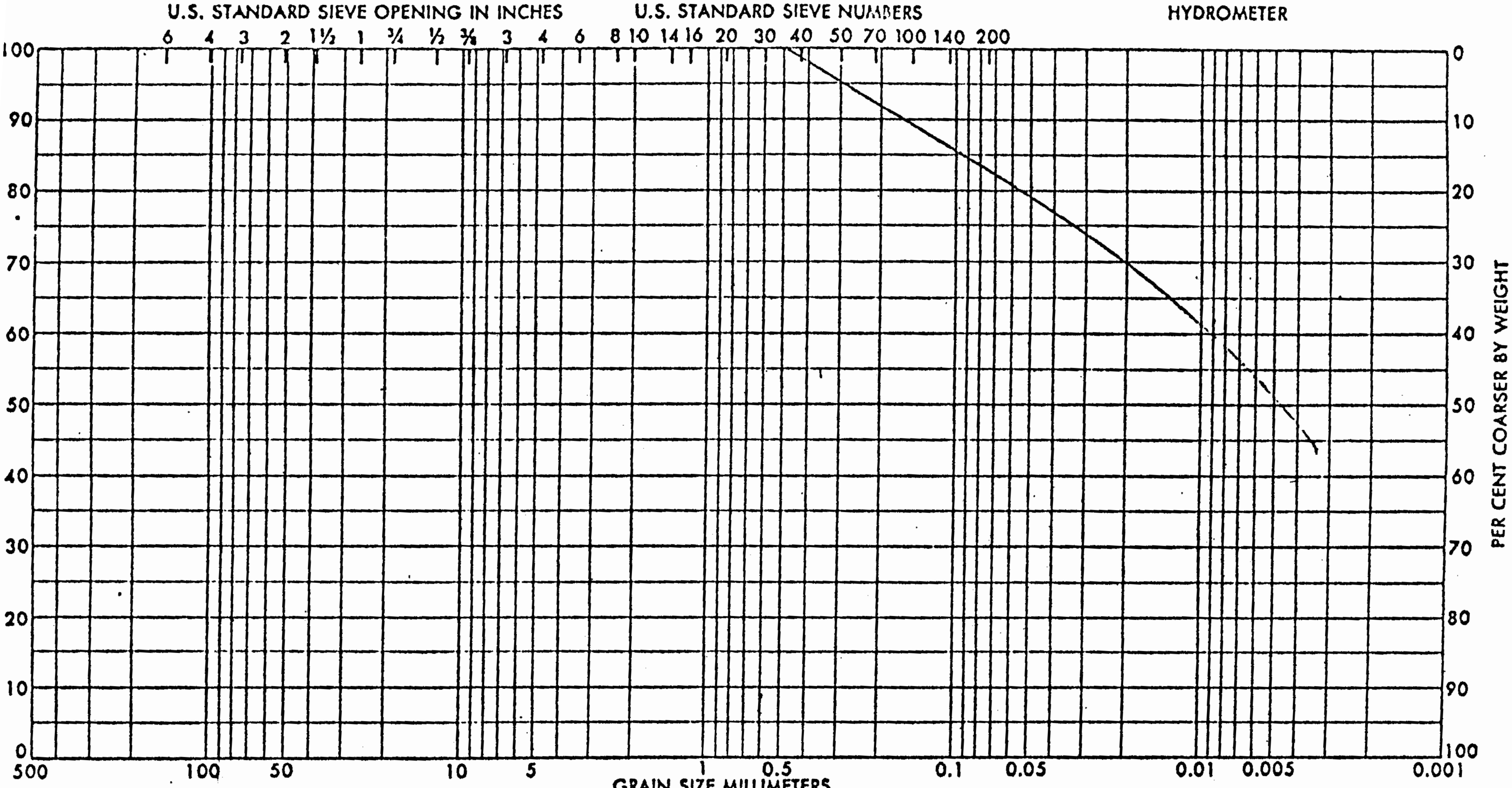
SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8		CL		38	20	18

PROJECT Quarantine Fill

D-78256-B

AREA

BORING NO. 14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
4		CL		28	18	10

PROJECT Quarantine Fill

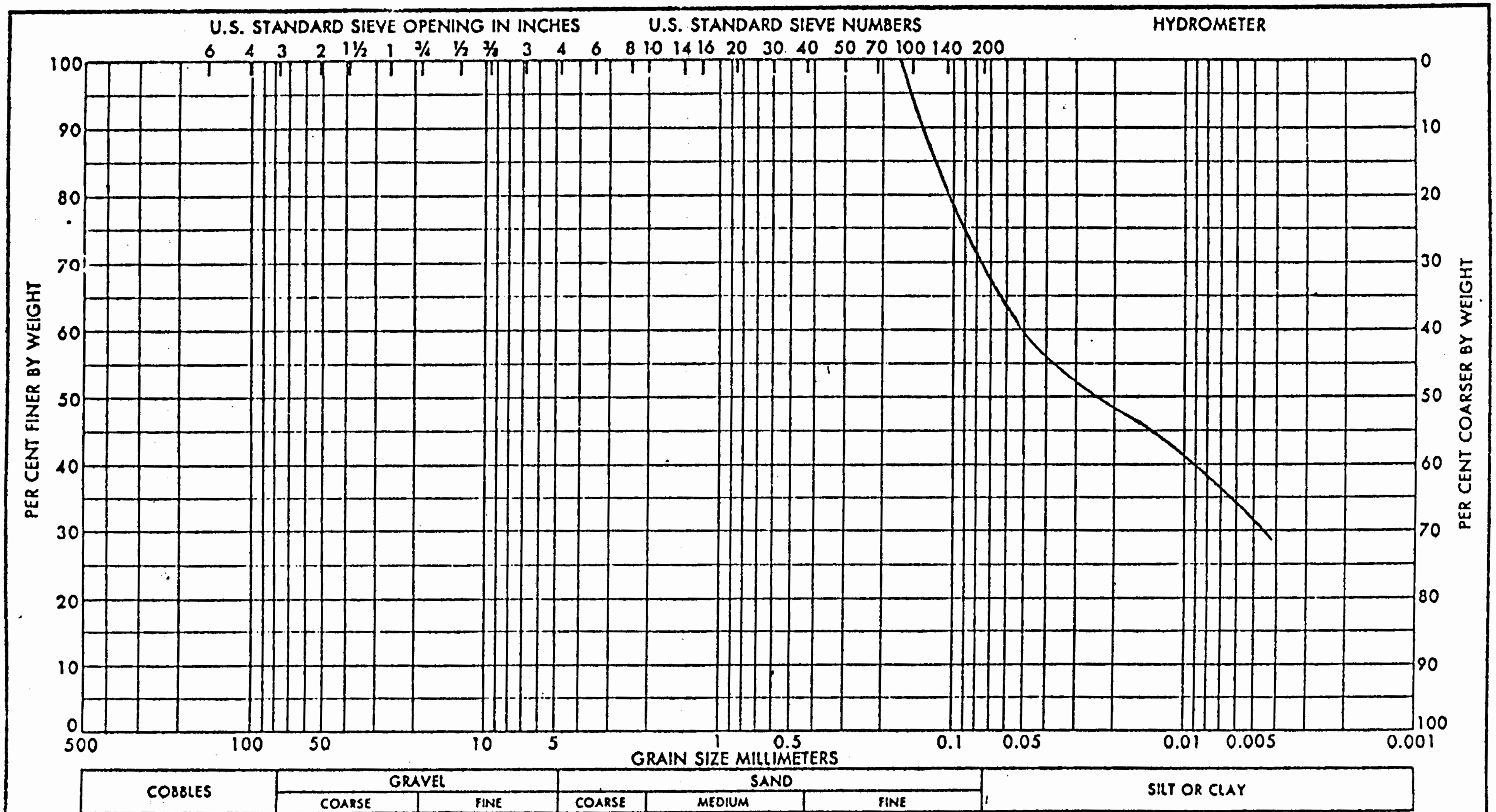
D- 78256-B

AREA

BORING NO. 15

DATE 9-15-78

GRADATION CURVES



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
8		CL		28	19	8

PROJECT Quarantine Fill
D-78256-B

AREA

BORING NO. 15

Clay Mineral Analyses

Sample Designation	Clay Minerals: Major	Clay Minerals: Minor
OW-7, S-10 48.5-50.0, E78256-B	Kaolinite Illite	none
OW-7, S-3 E78256	Kaolinite Illite	none
OW-13, S-6 E78256-B	Kaolinite Illite	none
OW-6, S-5 23.5-25.0, E78256-B	Kaolinite	Illite
OW-8, S-4 E78256-B	Kaolinite Illite	none
OW-5, S-6 28.5-30.0, E78256-B	Kaolinite	Illite

Samples supplied by: ATEC Associates

Analytical Method: X-ray Diffraction

Analyst: Paul Karabinos

Date: 17 July 1978

The Robert B. Balter Company
Geotechnical Engineers

18 Music Fa

Owings Mills, Maryla

July 25, 1978

Mr. Mark Aebig
ATEC Associates of Maryland, Inc.
9590 Berger Road
Columbia, Maryland 21046

Dear Mr. Aebig:

As requested, we have performed additional laboratory tests on the soil samples received on July 13, 1978. The samples were analysed for their cation exchange capacities based on the ammonium acetate procedure with the results summarized below:

Sample No. & Identification E-7B256-B	Total Cation Exchange Capacity. Miliequivalents Per 100 Grams	Remarks
OW 5 S # 6	5	Tan SILT & CLAY, tr f-
OW 6 S # 5	8	Purplish brown CLAY & little f sand.
OW 7 S # 3	9	Orangish brown SILT & tr f-m sand.
OW 7 S # 10	13	Tan SILT & CLAY, littl
OW 8 S # 4	13	Tan f-m SAND, some sil
OW 9 S # 6	2	Tan f-m SAND, tr silt.
OW 10 S # 6	13	Reddish brown CLAY & S little f-m sand.
OW 11 S # 5	10	Tannish brown SILT & (some f-m sand.
OW 13 S # 6	9	Reddish brown Clayey S f-m SAND.

The results indicate the samples to be basically Kaolinite.

If we may provide additional assistance, please feel free to call upon us.

Most sincerely,

The Robert B. Balter Company

By: Godfrey Nuwame

GN:mg
5700-MD

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-3
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-782
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vo
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Miscellaneous Landfill Materials						CA		Abandone hole @ 5
		5.0	5						
	Bottom of Test Boring @ 5.0'								
			10						
			15						
			20						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING ME
HSA -Hollow
CFA -Contin
DC -Drivin
MD -Mud Dr

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-3A

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 5/31/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 5/31/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Miscellaneous Landfill Materials						CA		Boring OW-3A was off-75' from OW-3 towards OW-6
		5.0	5						Abandoned test hole @ 5.0
	Bottom of Test Boring @ 5.0'								
			10						
			15						
			20						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ___ HRS. ___ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Aug

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-4 p
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-782
LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vol
Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector ____
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & NO
	SURFACE	0.0						"	
	Miscellaneous Landfill Materials								
			5	D/I	5 1/8	1	DS	10	
									Water or
			10	D	1 0/1	2	DS	1	
			15	D	3 2/4	3	DS	4	
			20	L	100 5	4	DS	L	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.
AFTER 24 HRS. ____ FT.

BORING
HSA-Hol
CFA-Con
DC -Dri
MD -Mu

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-4 pg 2of2

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5/31/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Miscellaneous Landfill Materials								
		25.0	25	L	100/3"	5	DS	L	
	Bottom of Test Boring @ 25.0'								
			30						
			35						
			40						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
...FLIGHT AUGER

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight A...
DC -Driving Casing

13

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW

PROJECT NAME Quarantine Road Sanitary Landfill JOB # I

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman ______

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 5/26/78 Pipe Size 2.0 In. Boring Method HSA Date Complete ______

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORI
	SURFACE	0.0						"	
	Gray and tan, moist, stiff Clayey SILT, trace Sand (ML)								
			5	D/I	2 4/7	1	DS	12	
		7.0							
	Reddish brown, gray and tan, moist, very stiff to hard Silty CLAY (CL) and Clayey SILT (ML), trace Sand								
			10	I	4 8/11	2	DS	16	
			15	D/I	11 14/16	3	DS	6	
			20	D/I	7 12/13	4	DS	5	

SAMPLE CONDITIONS ... ATED

SAMPLER TYPE DS-DRIVEN SPLIT SPOON

GROUND WATER DEPTH AT COMPLETION ______ FT

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-5 pg 2of4
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 5/26/28	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 5/26/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Reddish brown, gray and tan, moist, very stiff to hard Silty CLAY (CL) and Clayey SILT (ML), trace Sand								
			25	I	9 11/14	5	DS	18	
			30	D/I	12 27/33	6	DS	18	
			35	D/I	16 20/23	7	DS	18	
		37.0							
	Brown-gray, moist, hard Silty CLAY, trace fine Sand (CL)								
			40	D/I	20 30/60	8	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-5 n

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-

LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volen

Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector ____

Date Started 5/26/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & NO
	SURFACE	0.0						"	
	Brown-gray, moist, hard Silty CLAY, trace fine Sand (CL)	42.0							
	Brown, moist, hard Silty CLAY (CL)		45	D	21 23/29	9	DS	18	
			50	D/I	26 31/44	10	DS	18	
		52.0							
	Gray, moist, hard Silty CLAY (CL) and Clayey SILT (ML), trace Sand		55	D/I	20 30/41	11	DS	18	
			60	D/I	21 29/37	12	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.
AFTER 24 HRS. ____ FT.

BORING
HSA -Ho
CFA -Co
DC -Dr
MD -M

Atec
Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-5 pg 4of4
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/26/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5/27/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Gray, moist, hard Silty CLAY (CL) and Clayey SILT (ML), trace Sand	64.5							
	Tan, moist, very dense, Silty fine to medium SAND, trace Clay (ML)		65	D/I	40 61/80	13	DS	18	
			70	D	31 70/100/6"	14	DS	18	
		75.0	75	L	100/5"	15	DS	L	
	Bottom of Test Boring @ 75.0'								
			80						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing
MD -Mud Drilling

Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-6 pg 1

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-7825

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 5/27/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5/27

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLE NOTES
	SURFACE	0.0						"	
	Gray, moist, medium dense Clayey fine to medium SAND, little to some Silt (SC-SM)								
			5	D	7 10/6	1	DS	14	
		7.0							
	Reddish brown, tan and gray, moist, stiff to hard Silty CLAY, trace fine Sand (CL)								
			10	D/I	5 6/7	2	DS	18	Water on
			15	D/I	8 7/8	3	DS	14	
			20	D/I	15 20/26	4	DS		

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA -Hollo
CFA -Conti
DC -Drivin
MD -Mud D

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" IN

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-6 pg 2of4

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum		Hammer Wt.	140 Lbs.	Hole Diameter	8	Foreman	Volem
Surf. Elev.	Ft.	Hammer Drop	30 In.	Rock Core Dia.		Inspector	
Date Started	5/27/78	Pipe Size	2.0 In.	Boring Method	HSA	Date Completed	5/30/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Reddish brown, tan and gray, moist, stiff to hard Silty CLAY, trace fine Sand (CL)								
			25	I	12 13/16	5	DS	4	
			30	I	11 15/18	6	DS	18	
			35	I	10 14/16	7	DS	18	
			40	D/I	10 12/19	8	DS	18	

SAMPLE CONDITIONS
D–DISINTEGRATED
I–INTACT
U–UNDISTURBED
L–LOST

SAMPLER TYPE
DS–DRIVEN SPLIT SPOON
PT–PRESSED SHELBY TUBE
CA–CONTINUOUS FLIGHT AUGER
RC–ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA –Hollow Stem Augers
CFA –Continuous Flight Augers
DC –Driving Casing
MD –Mud Drilling

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-6 pg
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-
LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 5/27/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 5/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Reddish brown, tan and gray, moist, stiff to hard Silty CLAY, trace fine Sand (CL)		45	I	7 11/13	9	DS	18	
		47.0							
	Tan and gray, moist, hard Clayey and Sandy SILT (ML)		50	I	7 18/27	10	DS	18	Water on r
		54.5	55	D/I	44 100/3"	11	DS	8	
	Tan and gray, moist to saturated, very dense, Silty fine SAND, trace Clay (SM)		60	D	71 100/5"	12	DS	10	

SAMPLE CONDITIONS	SAMPLER TYPE	GROUND WATER DEPTH	BORING M
D-DISINTEGRATED	DS-DRIVEN SPLIT SPOON	AT COMPLETION FT.	HSA-Hollo
I-INTACT	PT-PRESSED SHELBY TUBE	AFTER HRS. FT.	CFA-Conti
U-UNDISTURBED	CA-CONTINUOUS FLIGHT AUGER	AFTER 24 HRS. FT.	DC -Drivi
L-LOST	RC-ROCK CORE		MD -Mud D

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" I

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-6 pg 4of4
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/27/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 5/30/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Tan and gray, moist to saturated, very dense, Silty fine SAND, trace Clay (SM)								
			65	D	39 100 6	13	DS	10	
			70	D	100 5	14	DS	5	Observation well set @ 73.5'
		72.0							
	Gray and tan, moist, hard Clayey and Sandy SILT (ML)								5/30/78 Water at completic @ 63.0'
		75.0	75	D/I	79 100 4	15	DS	9	
	Bottom of Test Boring @ 75.0'								
									6/1/78 Water @ 59.5'
			80						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing
MD -Mud Drilling

FORM 102

PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-7
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-782
LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volc
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 5/31/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Brown and black, moist, loose Silty SAND (SM)								
			5	D	9 4/4	1	DS	6	
		6.0							
	Light gray, moist, very stiff Clayey SILT, light fine Sand (ML-CL)								
		9.0							
	Brown and gray, moist, medium dense clayey fine SAND, little Silt (SC)		10	D/I	10 14/18	2	DS	12	
		12.0							
	Mottled reddish brown, tan and gray, moist, hard, Silty CLAY (CL)		15	I	14 17/23	3	DS	18	
		17.0							
	Light gray, moist, very stiff Clayey SILT, trace to little fine Sand (ML)		20	D/I	7 10/18	4	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING ME
HSA-Hollow
CFA-Contin
DC -Driving
MD -Mud Dr

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-7
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/1/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	Light gray, moist, very stiff Clayey SILT, trace to little fine Sand (ML)	22.0							
	Light gray and tan, moist, hard Sand and Clayey SILT (ML)			D	14 19/33	5	DS	16	
			25						
				D/I	17 19/33	6	DS	14	
			30						
				U		6A	PT	12	Sample 6A- Pushed tube 6" to refusal. Then drove tube another 6" with a 140l hammer. Tube became bent and could not b driven any further.
		33.0							
	Light gray and tan, moist, very dense Silty fine SAND, trace Clay and Clay seams. (SM)			D	100/5.5"	7	DS	5.5	
			35						
				D	59 100/5"	8	DS	10	
			40						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing
MD -Mud Drilling

Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volen
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed ______

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & S... NOT...
								"	
	Light gray and tan, moist, very dense Silty fine SAND, trace Clay and Clay seams (SM)	42.0							
	Light gray and tan, moist medium dense Clayey fine SAND, little to some Silt (SC) or (ML)		45	I	100/5"	9	DS	5	
			50	D/I	106/6"	10	DS	6	
	Light gray to tan, moist, Silty fine SAND, trace Clay	52.0	55	D	75 100/3"	11	DS	9	
			60	D	100/5"	12	DS	6	

SAMPLE CONDITIONS	SAMPLER TYPE	GROUND WATER DEPTH	BORING MET...
D-DISINTEGRATED	DS-DRIVEN SPLIT SPOON	AT COMPLETION ______ FT.	HSA-Hollow S...
I-INTACT	PT-PRESSED SHELBY TUBE	AFTER ______ HRS. ______ FT.	CFA-Continuo...
U-UNDISTURBED	CA-CONTINUOUS FLIGHT AUGER	AFTER 24 HRS. ______ FT.	DC -Driving C...
L-LOST	RC-ROCK CORE		MD -Mud Drill...

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INT...

AHC Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-7 Page 4 of 5
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/1/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec. "	BORING & SAMPLING NOTES
	Light gray to tan, moist, Silty fine SAND, trace Clay								
				D	100/6"	13	DS	6	
			65						
				D	100/6"	14	DS	6	
			70						
				D	100/6"	15	DS	6	
			75						
				D	100/6"	16	DS	6	
			80						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA-Continuous Flight Augers
DC -Driving Casing
MD -Mud Drilling

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

Form 102

AI&C
Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-7 Pa
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-
LOCATION Baltimore, Maryland

SAMPLER

Datum ________ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ________ Ft. Hammer Drop 30 In. Rock Core Dia. ________ Inspector ________
Date Started 5/31/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & S... NOTE
								"	
	Light gray to tan, moist, Silty fine SAND, trace Clay	82.0							
	Reddish brown, very moist, very dense Silty fine SAND with Clay and Silt seams			D	100/5.5	17	DS	5.5	
			85						Observatic set @ 88.
		90	90	D/I	100/5"	18	DS	5	
	Bottom of Test Boring @ 90.0'								6/1/78 Dry
			95						
			100						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ________ FT.
AFTER ________ HRS. ________ FT.
AFTER 24 HRS. ________ FT.

BORING M...
HSA-Hollo...
CFA-Conti...
DC -Drivin...
MD -Mud C...

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" I...

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 6/2/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 6/2/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Brown, moist, loose, Silty fine to medium SAND (SM)		5	D	3 3/3	1	DS	6	
		7.0							
	Black, moist, soft, organic Silty CLAY (CL-OL)		10	D	3 3/2	2	DS	4	
		12.0							
	Tan, very moist, medium dense Clayey SAND (SC) and Silty SAND, trace organic matter (SM)		15	D	6 5/7	3	DS	12	
		17.0							
	Gray and tan, moist, medium dense, Silty SAND(SM) and Clayey SAND (SC)		20	D	12 17/10	4	DS	16	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION FT.
AFTER HRS. FT.
AFTER 24 HRS. FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA -Continuous Flight Augers
DC -Driving Casing
MD -Mud Drilling

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING #OW 8 Pag

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-7

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 6/2/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Gray and tan, moist, medium dense, Silty SAND (SM) and Clayey SAND (SC)		25	D/I	3 6/10	5	DS	16	
		27.0							
	Tan and gray, moist, very stiff to hard, Silty CLAY, little fine Sand (CL)		30	I	10 12/16	6	DS	18	
			35	I	12 18/22	7	DS	18	
		37.0							
	Reddish brown, tan and gray, moist, dense Clayey SAND (SC) and Silty SAND (SM) with clay seams	39.0							Water on
	Reddish brown, purple & gray, moist, hard, Silty CLAY, trace fine Sand (CL)		40	D/I	22 23/24	8	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING ME
HSA-Hollow
CFA-Continu
DC -Driving
MD -Mud Dr

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INT

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 8 Page 3 of 3

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 6/2/78	Pipe Size 2.0 In.	Boring Method HS I	Date Completed 6/2/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Reddish brown, purple & gray, moist, hard, Silty CLAY, trace fine Sand (CL)			I	40 60/79	9	DS	18	
			45						
				I	22 33/45	10	DS	18	Observation well set @ 48.5'
			50						
				I	21 29/48	11	DS	18	
			55						
		57.0							
	Dark gray, moist, hard Sandy CLAY (CL)	60.0		I	29 31/49	12	DS	18	
			60						
	Bottom of test boring @ 60.0'								

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION 23.0 FT.
AFTER HRS. FT.
AFTER 24 HRS. 11.0 FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Auger
DC -Driving Casing
MD -Mud Drilling

ATEC Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 9
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volc
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 6/12/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & NO
	SURFACE	0.0						"	
	Reddish brown, moist, very stiff, Sandy & Silty CLAY (CL-ML)								
			5	D	10 11/14	1	DS	8	
		7.0							
	Light gray and tan, moist, medium dense to very dense, Silty fine to medium SAND (SM), with Clayey SAND (SC) and Silty CLAY (CL) seams								
			10	D	12 12/17	2	DS	14	
			15	D	12 14/20	3	DS	14	
			20	D	12 20/26	4	DS	16	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA-Hollo
CFA-Conti
DC -Drivi
MD -Mud C

FOR

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" I

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 9

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Volem
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 6/12/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 6/12/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Light gray and tan, moist, medium dense to very dense, Silty fine to medium SAND (SM), with Clayey SAND (SC) and Silty CLAY (CL) seams		25	D	14 24/30	5	DS	16	
			30	D	22 33/41	6	DS	10	
			35	D	60 100/5"	7	DS	8	
			40	D	21 29/32	8	DS	14	

SAMPLE CONDITIONS
D–DISINTEGRATED
I–INTACT
U–UNDISTURBED

SAMPLER TYPE
DS–DRIVEN SPLIT SPOON
PT–PRESSED SHELBY TUBE
CA–CONTINUOUS FLIGHT AUGER
RC–ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA –Hollow Stem Augers
CFA –Continuous Flight Au
DC –Driving Casing
MD –Mud Drilling

FORM

AIEC Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 9

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vo

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 6/12/78 Pipe Size 2.0 In. Boring Method HS 1 Date Completed 6/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & NOT
	SURFACE	0.0						"	
	Light gray and tan, moist, medium dense to very dense, Silty fine to medium SAND (SM), with Clayey SAND (SC) and Silty CLAY (CL) seams	42.0							
	Mottled reddish brown, tan and gray, moist, hard Sandy Clayey SILT (ML) and Silty CLAY (CL) little fine Sand		45	I	26 28/40	9	DS	16	
		49.0							Water on r
	Tan and gray, saturated, very dense, Silty fine SAND (SM-SP)		50	D/I	36 49/100/6"	10	DS		
				U		10A	PT	lost	Two attemp made to ta 10A, howev covery was
			55	D	61 100/5"	11	DS	9	
									Observatior set @ 58.5'
		60.0	60	D	100/5"	12	DS	3	
	Bottom of test boring @ 60.0'								

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION 50.0 FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. 43.5 FT.

BORING MET
HSA-Hollow S
CFA-Continuc
DC -Driving
MD -Mud Dril

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INT

AIRC
Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-10 pg 1of3
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 6/13/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/13/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Brown, moist to very moist, loose Silty fine medium SAND, trace of CLAY (SM)								Surface Water
			5	D/I	5 4/5	1	DS	8	
	Tan, gray and reddish brown, moist to very moist, very stiff to hard Silty CLAY, trace of SAND (CL)	7.0							
			10	D/I	8 10/14	2	DS	16	Water on rods@ 13.
			15	D/I	8 12/18	3	DS	10	
			20	I	6 12/13	4	DS	14	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA-Continuous Flight Auge
DC -Driving Casing
MD -Mud Drilling

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-10

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D

LOCATION Baltimore, Maryland

SAMPLER

Datum		Hammer Wt.	140 Lbs.	Hole Diameter	8
Surf. Elev.	Ft.	Hammer Drop	30 In.	Rock Core Dia.	
Date Started	6/13/78	Pipe Size	2.0 In.	Boring Method	HSA

Foreman Vo

Inspector

Date Completed 6

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec.	BORING & NO
	SURFACE	0.0						"	
	Tan, Gray and reddish brown, moist to very moist, very stiff to hard Silty Clay, trace of SAND (CL)			D/I	10 12/18	5	DS	16	
			25						
				D/I	14 19/34	6	DS	18	
			30						
		32.0							
	Gray and tan, moist, hard, Clayey SILTY, trace to little fine SAND (ML)			D/I	10 23/33	7	DS	18	
			35						
		37.0							
	Tan and gray, very moist, dense, Clayey fine SAND, little silt (SC)			D	15 18/26	8	DS	16	
			40						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA-Hollo
CFA-Conti
DC -Drivi
MD -Mud D

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW-10 pg 3of3
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 6/13/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/13/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Gray, moist, hard Silty CLAY, trace of SAND (CL-ML)	42.0							Water on rods @43.5'
				D/I	27 30/51	9	DS	18	
			45						
		47.0							
	Tan and gray, moist to saturated, very dense Silty fine SAND, trace of CLAY (SM)			D/I	23 41/75	10	DS	18	
			50						
									Augers @ 53.5'
									Water @ 42.0'
				D	61 100/5"	11	DS		
			55						Observation well set @ 53.5'
	Bottom of Test Boring @ 55.0'								
			60						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Augers
DC -Driving Casing

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 11 P

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-732

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 6/14/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/1

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Tan, moist to saturated, medium dense, Silty fine to medium SAND (SM-SP)								
				D	8 10/8	1	DS	8	
			5						
									Water on
	Sample 2-Saturated			D	8 9/9	2	DS	14	
			10						
		12.0							
	Tan and gray, moist, very stiff to stiff, Silty CLAY (CL)								
				I	1 10/10	3	DS	12	
			15						
				I	6 7/10	4	DS	18	
			20						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA -Hollow
CFA -Contin
DC -Drivin
MD -Mud D

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" IN

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 11 Page 1 of 3

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-73256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector ____

Date Started 6/14/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/14/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & SAMPLING NOTES
	SURFACE	0.0							
	Tan, moist to saturated, medium dense, Silty fine to medium SAND (SM-SP)								
			5	D	8 10/8	1	DS	8	
									Water on rods @ 8.0'
	Sample 2-Saturated		10	D	8 9/9	2	DS	14	
		12.0							
	Tan and gray, moist, very stiff to stiff, Silty CLAY (CL)								
			15	I	1 10/10	3	DS	12	
			20	I	6 7/10	4	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.
AFTER 24 HRS. ____ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Auger
DC -Driving Casing
MD -Mud Drilling

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 11 Pa

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-

LOCATION Baltimore, Maryland

SAMPLER

Datum	Hammer Wt. 140 Lbs.	Hole Diameter 8	Foreman Vol
Surf. Elev. Ft.	Hammer Drop 30 In.	Rock Core Dia.	Inspector
Date Started 6/14/78	Pipe Size 2.0 In.	Boring Method HSA	Date Completed 6/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SA NOTE
	SURFACE	0.0						"	
	Tan and gray, moist, very stiff to stiff, Silty CLAY (CL)			I	4 5/6	5	DS	18	
		27.0	25						
	Tan, moist, dense, Clayey SAND (SC) and gray, moist, hard, Silty CLAY (CL-ML)			D/I	12 15/16	6	DS	18	
		32.0	30						
	Gray, moist, hard CLAY and Sandy SILT (ML)			I/D	12 20/37	7	DS	18	Water on r
		35.0	35						
	Brown and reddish brown, moist, very dense Clayey SAND, little to some SILT (SC)			I/D	32 25/36	8	DS	18	
		39.5	40						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING MET
HSA-Hollow S
CFA-Continuo
DC -Driving
MD -Mud Dril

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" INT

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING #OW 11 Page 3 o

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 6/14/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/14/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Brown and reddish brown, moist, very dense Clayey SAND, little to some SILT (SC)	42.0							
	Gray, very moist, hard, Sandy CLAY (CL) or very dense CLAY, fine SAND (SC)		45	D/I	24 31/59	9	DS	18	
			50	I	18 20/39	10	DS	18	
			55	I	17 21/29	11	DS	18	Observation well set at 58.0 ft.
		57.0							
	Dark gray, moist, hard CLAY and Sandy SILT (ML), trace organic matter	60.0	60	I/D	17 24/28	12	DS	18	
	Bottom of test boring @ 60.0'								

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION 21.0 FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. 23.5 FT.

BORING METHOD
HSA -Hollow Stem Augers
CFA -Continuous Flight Auger
DC -Driving Casing
MD -Mud Drilling

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 12 P

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vole

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 6/3/78 Pipe Size 2.0 In. Boring Method HSA Date Completed ______

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & S NOT
	SURFACE	0.0						"	
	Reddish brown, gray and tan, moist to very moist, medium stiff to very stiff, Silty CLAY (CL)		5	D/I	8 6/10	1	DS	18	
			10	I	9 9/12	2	DS	18	
			15	I	2 3/4	3	DS	18	
			20	D/I	6 6/7	4	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING ME
HSA-Hollow
CFA-Contin
DC -Drivin
MD -Mud D

*STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER ... WITH 140# HAMMER FALLING 30" ...

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 12 Page 2 of
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem
Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector ____
Date Started 6/3/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/3/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Reddish brown, gray and tan, moist to very moist, medium stiff to very stiff, Silty CLAY (CL)		25	D/I	3 4/6	5	DS	18	
		27.0							
	Brown to dark gray, moist medium stiff, Silty CLAY (CL), trace to little organic matter	30.0	30	D/I	3 4/5	6	DS	18	
	Brown, very moist, loose to dense, Silty fine to medium SAND, trace to little Clay (SM)	34.0							
	Gray, moist, hard, Silty and Sandy CLAY (CL)	37.0	35	D/I	8 12/20	7	DS	18	
	Gray, moist to saturated, fine to medium SAND (SM)		40	D	18 20/7	8	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing

FORM 1

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. — OW BORING # 12 Page
PROJECT NAME Quarantine Road Sanitary Landfill — JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum		Hammer Wt.	140 Lbs.	Hole Diameter	8	Foreman	Vol
Surf. Elev.	Ft.	Hammer Drop	30 In.	Rock Core Dia.		Inspector	
Date Started	6/3/78	Pipe Size	2.0 In.	Boring Method	HSA	Date Completed	

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec.	BORING & NOT
	SURFACE	0.0						"	
	Gray, moist to saturated, fine to medium SAND (SM)								
			45	D	39 71/80	9	DS	10	Observati set at 48
	Samples 9 and 10 saturated								
		50.0	50	D	100 5	10	DS	5	
	Bottom of test boring @ 50.0'								
			55						
			60						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION 26.0 FT.
AFTER ____ HRS. ____ FT.
AFTER 24 HRS. ____ FT.

BORING
HSA -Holl
CFA -Cont
DC -Driv
MD -Mud

*STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6"

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 13 Page 1 of 4

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector ____

Date Started 6/15/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/15/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Mottled reddish brown, tan and gray, moist, very stiff Silty CLAY (CL)		5	I	7 9/11	1	DS	16	
		7.0							
	Reddish brown, moist, medium dense, Clayey fine SAND, little SILT (SC)		10	D/I	8 8/8	2	DS	18	
			15	D/I	6 10/10	3	DS	15	
		17.0							
	Mottled reddish brown, tan and gray, moist, medium stiff to very stiff Silty CLAY (CL), with Sandy CLAY (CL) seams		20	D/I	4 5/6	4	DS	12	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.
AFTER ____ 24 HRS. ____ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Au
DC -Driving Casing
MD -Mud Drilling

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 13
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-782
LOCATION Baltimore, Maryland

SAMPLER

Datum \ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vo
Surf. Elev. Ft. Hammer Drop 30 In. Rock Core Dia. Inspector
Date Started 6/15/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec. "	BORING & HO
	SURFACE	0.0							
	Mottled reddish brown, tan and gray, moist, medium stiff to very stiff Silty CLAY (CL), with Sandy CLAY (CL) seams		25	D/I	5 7/10	5	DS	14	
			30	D/I	7 8/9	6	DS	18	
				4		GA	PT	14	
			35	I	2 4/6	7	DS	16	
			40	I	3 4/4	8	DS	11	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA-Hollo
CFA-Conti
DC -Drivi
MD -Mud

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 13 Page 3 of

PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-73256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ____ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Volem

Surf. Elev. ____ Ft. Hammer Drop 30 In. Rock Core Dia. ____ Inspector -

Date Started 6/15/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 6/15/78

ELEV.	SOIL DESCRIPTION (Color, Moisture, Density, Plasticity, Size, Proportions)	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Mottled reddish brown, tan & gray, moist, medium stiff to very stiff Silty CLAY (CH), with Sandy CLAY (CL) seams	42.0							
	Brown and gray, Clayey SAND (SC)	44.0							
	Dark gray to black, moist, medium stiff to stiff Silty CLAY (CL) and Clayey SILT (ML), trace to little organic matter		45	D/I	3 4/5	9	DS	18	
			50	D/I	4 6/7	10	DS	18	Water on rods @ 50.0'
		54.5							
	Gray, very moist, medium stiff to very stiff, Clayey SILT, little fine Sand (ML)		55	D/I	3 5/5	11	DS	18	
		59.0							
	Brown, very moist, very stiff, Clayey SILT, little Sand (ML-CL)		60	D/I	8 8/10	12	DS	18	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.
AFTER 24 HRS. ____ FT.

BORING METHOD
HSA - Hollow Stem Augers
CFA - Continuous Flight Au[gers]
DC - Driving Casing
MD - Mud Drilling

FORM 1

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Browning-Ferris Industries, Inc. BORING # OW 13
PROJECT NAME Quarantine Road Sanitary Landfill JOB # D-7825
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 8 Foreman Vol
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 6/15/78 Pipe Size 2.0 In. Boring Method HSA Date Completed ______

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & NO
	SURFACE	0.0						"	
	Brown, very moist, very stiff, Clayey SILT, little Sand (ML-CL)	62.0							Observat set at 6
	Reddish brown, moist, hard Silty CLAY (CL)	65.0	65	I	14 23/31	13	DS	18	
	Bottom of test boring @ 65.0'		70						
			75						
			80						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION 50.0 FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA-Hollo
CFA-Conti
DC -Drivi
MD -Mud D

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Harrington Lacey and Associates, Inc. BORING # W - 14 Page 1 of 3

PROJECT NAME Quarantine Road JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 10" Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 8/4/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 8/4/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	SURFACE	0.0						"	
	Red, brown to gray, moist, loose to medium dense Silty SAND (SM)								
			5	D/I	5 5/5	1	DS	5	
									Water on Rods 8'
			10	D	6 14/13	2	DS	12	
		12.0							
	Red, brown, moist, dense Silty fine SAND (SM)								
			15	I	10 15/19	3	DS	18	
		17.0							
	Gray and red, moist, hard, Clayey SILT (ML)								
			20	I	11 18/23	4	DS	18	(A) Caved In @ 48.0 (B) Caved In @ 44.0

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION Dry (A) FT.
AFTER 8 HRS. 43 (B) FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight Aug
DC -Driving Casing
MD -Mud Drilling

FORM 1

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Harrington Lacey and Associates, Inc. BORING # W - 14 P
PROJECT NAME Quarantine Road JOB # D-78256-
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 10" Foreman Vole
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 8/4/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 8/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & SA NOTE
	Cont	20.0						"	
	Gray and red, moist, hard, Clayey SILT (ML)								
			25	I	14 19/25	5	DS	18	
			30	I	14 22/27	6	DS		
			35	I	16 19/26	7	DS	18	
			40	I	23 32/44	8	DS	18	(A) Caved (B) Caved

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION Dry (A) FT.
AFTER 8 HRS. 43 (B) FT.
AFTER 24 HRS. ______ FT.

BORING M
HSA-Hollow
CFA-Conti
DC -Drivin
MD -Mud D

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" I

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Harrington Lacey and Associates, Inc. BORING # W - 14 Page 3 of
PROJECT NAME Quarantine Road JOB # D-78256-B
LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 10" Foreman Volem
Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______
Date Started 8/4/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 8/4/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	Cont	40.0						"	
	Gray and red, moist, hard, Clayey SILT (ML)								
			45	I	23 34/46	9	DS	18	
		50.0	50	I	21 37/49	10	DS	18	
	Bottom of Test Boring @ 50'								
			55						
			60						(A) Caved in @ 48. (B) Caved in @ 44.

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION Dry (A) FT.
AFTER 8 HRS. 43.0(B) FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Auger
CFA-Continuous Flight
DC -Driving Casing
MD -Mud Drilling

FORM 102

Associates of Maryland, inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Harrington Lacey and Associates, Inc. BORING # W - 15 I

PROJECT NAME Quarantine Road JOB # D-78256-I

LOCATION Baltimore, Maryland

SAMPLER

Datum ________ Hammer Wt. 140 Lbs. Hole Diameter 10" Foreman Volem

Surf. Elev. ________ Ft. Hammer Drop 30 In. Rock Core Dia. ________ Inspector ________

Date Started 8/4/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 8/

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	SAMPLE Cond.	Blows/6"*	No.	Type	Rec.	BORING & SA NOTES
	SURFACE	0.0						"	
	Red, brown to dark gray, moist, loose to medium dense Silty SAND (SM)								
			5	D	3 4/2	1	DS	4	
		9.5							
	Gray, moist, medium dense Silty fine SAND (SM)		10	D/I	11 11/12	2	DS	18	
		12.0							
	Dark gray, saturated, very loose Silty SAND (SM)		15	D	3 1/2	3	DS	5	
		17.0							
	Brown, wet, medium dense Silty fine SAND (SM)		20	D	7 6/8	4	DS	10	

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ________ FT.
AFTER ________ HRS. ________ FT.
AFTER 24 HRS. ________ FT.

BORING M
HSA-Hollo
CFA-Conti
DC -Drivin
MD -Mud C

*STANDARD PENETRATION TEST-DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30"; COUNT MADE AT 6" I

Atec Associates of Maryland, Inc.

RECORD OF SOIL EXPLORATION

CONTRACTED WITH Harrington Lacey and Associates, Inc. BORING # W - 15 Page 2 of

PROJECT NAME Quarantine Road JOB # D-78256-B

LOCATION Baltimore, Maryland

SAMPLER

Datum ______ Hammer Wt. 140 Lbs. Hole Diameter 10" Foreman Volem

Surf. Elev. ______ Ft. Hammer Drop 30 In. Rock Core Dia. ______ Inspector ______

Date Started 8/4/78 Pipe Size 2.0 In. Boring Method HSA Date Completed 8/4/78

ELEV.	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size, Proportions	STRA. DEPTH	DEPTH SCALE	Cond.	Blows/6"	No.	Type	Rec.	BORING & SAMPLING NOTES
	Cont	20.0						"	
	Brown, wet, medium dense Silty fine SAND (SM)								
		22.0							
	Dark gray, saturated very loose Silty SAND (SM)								
				D	2 2/1	5	DS		
			25						
		27.0							
	Brown, wet, loose to very loose fine Sandy SILT, trace Clay (ML)								
				I	7 4/5	6	DS	5	
			30						
				U		6A	PT		
				D	2/2	7	DS	10	
			35						
		38.0							
	Bottom of Test Boring @ 38.0'								
			40						

SAMPLE CONDITIONS
D-DISINTEGRATED
I-INTACT
U-UNDISTURBED
L-LOST

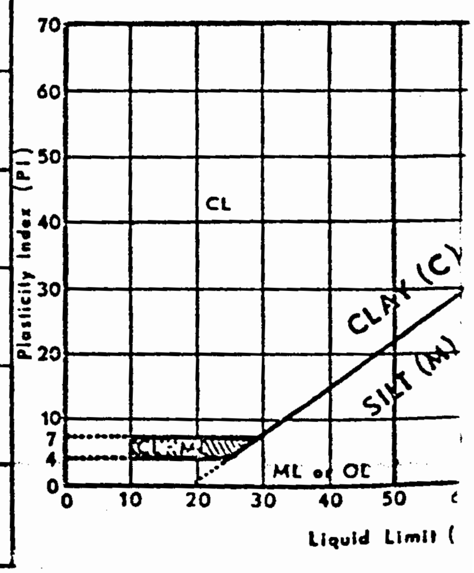
SAMPLER TYPE
DS-DRIVEN SPLIT SPOON
PT-PRESSED SHELBY TUBE
CA-CONTINUOUS FLIGHT AUGER
RC-ROCK CORE

GROUND WATER DEPTH
AT COMPLETION ______ FT.
AFTER ______ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD
HSA-Hollow Stem Augers
CFA-Continuous Flight A
DC -Driving Casing
MD -Mud Drilling

Unified Soil Classification System

Major divisions			Group Symbol	Typical names	Laboratory classification	
COARSE GRAINED SOILS (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve)	Clean gravels	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse grained soils are classified as follows: Less than 5% ......GW, GP, SW, SP More than 12% ......GM, GC, SM, SC 5 to 12% ....Borderline cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}} > 4$; 1<
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve)	Clean sands	SW	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}} > 6$; 1<
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradatio
		Sands with fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7
FINE GRAINED SOILS (More than half of material is smaller than No. 200 sieve)	Silts and clays (LL less than 50)		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	1. Plot intersection of PI and LL as de Atterberg Limits tests. 2. Points plotted above A line indicat below the A line indicate silt.	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL	Organic silts and organic silty clays of low plasticity		
	Silts and clays (LL greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH	Inorganic clays of high plasticity, fat clays		
			OH	Organic clays of medium to high plasticity, organic silts		
	Highly Organic Soils		Pt	Peat and other highly organic soils		



Plasticity C

ATEC Associates, Inc.
of Maryland
Geotechnical and Materials Engineers

Unified Soil Class

ASTM Designat

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Density	
Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	- 11 to 30 blows/ft.
Dense	- 31 to 50 blows/ft.
Very Dense	- 51 blows/ft. or more

Relative Proportions

Descriptive Term	Percent
Trace	1-10
Little	11-20
Some	21-35
And	36-50

Particle Size Identification

Particle Size Identification		
Boulders	- 8 inch diameter or more	
Cobbles	- 3 to 8 inch diameter	
Gravel	- Coarse	- 1 to 3 inch
	Medium	- ½ to 1 inch
	Fine	- ¼ to ½ inch
Sand	- Coarse	- 0.6mm to ¼ inch (dia. of pencil lead)
	Medium	- 0.2mm to 0.6mm (dia. of broom stra
	Fine	- 0.05mm to 0.2mm (dia. of human hai
Silt		- 0.6mm to 0.002mm (Cannot see particl

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency

Consistency	
Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	- 11 to 15 blows/ft.
Very Stiff	- 16 to 30 blows/ft.
Hard	- 31 blows/ft. or more

Plasticity

Degree of Plasticity	Plasticity Index
None to slight	0- 4
Slight	5- 7
Medium	8-22
High to Very High	over 22

Classification on logs are made by visual inspection of samples.

Standard Penetration Test — Driving a 2.0" O.D., 1-3/8" I.D., sampler a distance of 1.0 foot into un turbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for ATE drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of ham blows for seating the spoon and making the test are recorded for each 6.0 inches of penetration on the log (Example — 6/8/9). The standard penetration test result can be obtained by adding the last figures (i.e. 8 + 9 = 17 blows/ft.). (ASTM D-1586-67)

Strata Changes — In the column "Soil Descriptions" on the drill log the horizontal lines represent st changes. A solid line (______) represents an actually observed change, a dashed line (_ _ _ _ _) repres an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditi site topography, etc., may cause changes in the water levels indicated on the logs.

APPENDIX B

MISCELLANEOUS SUBSURFACE

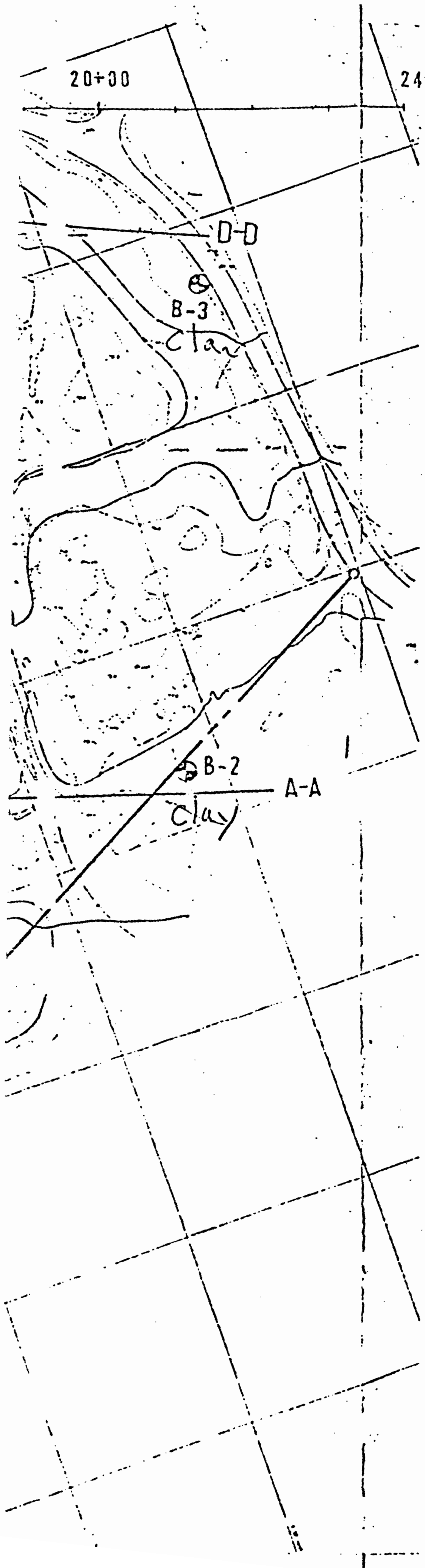
INVESTIGATION DATA

1. MCA, Inc. Boring Logs
2. Water Resources Administration; Hawkins Point Disposal Area Boring Logs
3. State Highway Administration; Outer Harbor Crossing Boring Logs

MCA ENGINEERING CORPORATION

TEST BORING DATA

The attached data represent information exerpted from Engineering Feasibility Report; Proposed Quarantine Road Landfill; Curtis Bay, Maryland prepared for Glidden-Durkee, Inc., Division of SCM Corporation by MCA Engineering Corporation (December, 1976).

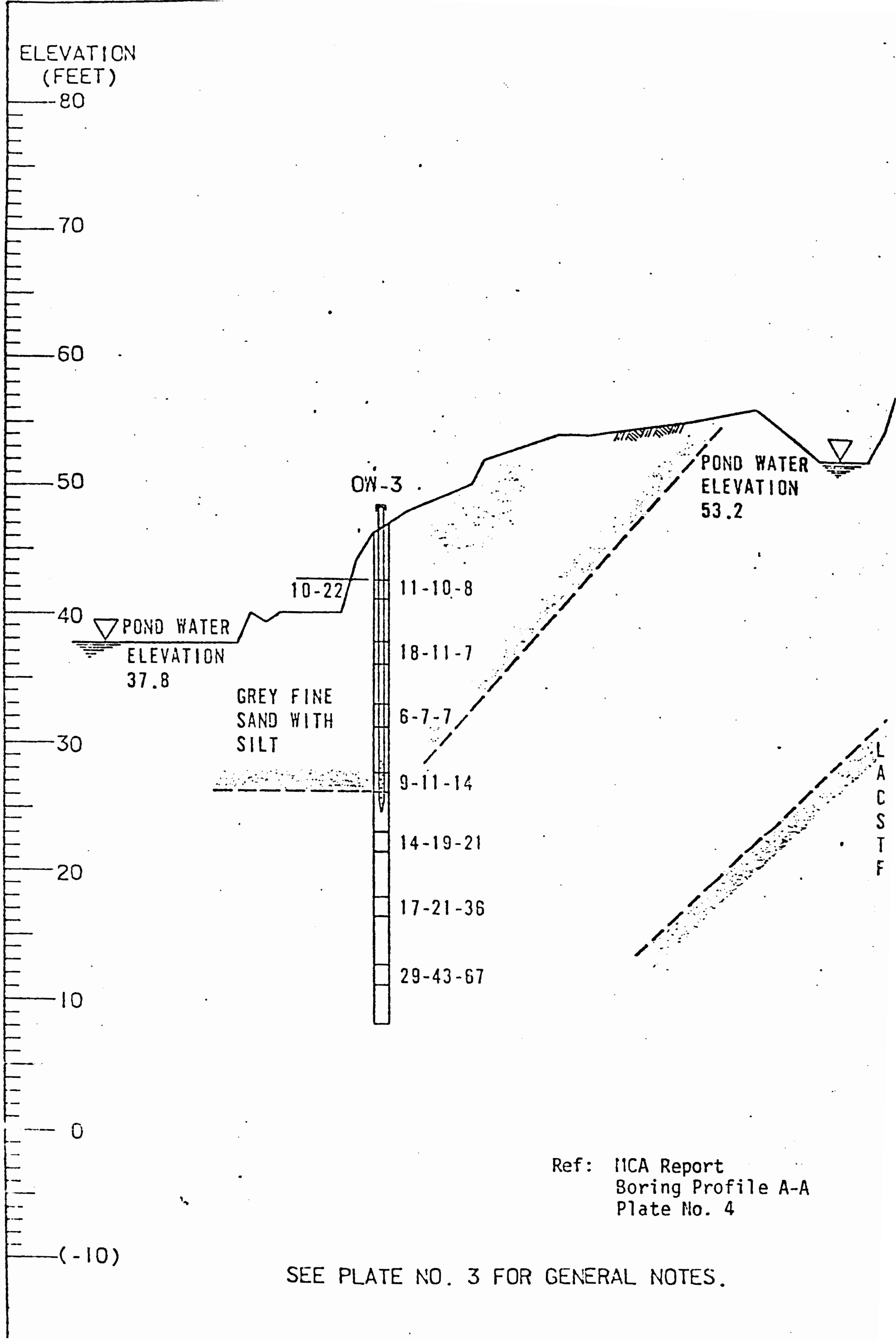


NOTES:

1. THE PROPERTY LINES SHOWN ON THIS P
   ARE APPROXIMATE.
2. TEST BORINGS PERFORMED BY MCA ENGI
   CORPORATION IN SEPTEMBER AND OCTOB
3. FOR TEST BORING PROFILES A-A, B-B,
   AND D-D SEE PLATE NO. 4, 5, 6 AND
   RESPECTIVELY.
4. THE NUMBERS IN THE COLUMNS ON THE
   PROFILES INDICATE THE NUMBER OF BL
   WITH A 140 LB. HAMMER FALLING FREE
   30 INCHES REQUIRED TO DRIVE A 2" C
   SAMPLER SIX INCHES. THE SAMPLE IN
   IS INDICATED ON THE BORING STRIP.
5. GROUNDWATER LEVELS SHOWN ON THE BO
   PROFILES ARE THE HIGHEST OBSERVED
   A COMPLETE LISTING OF OBSERVED GR
   LEVELS IS GIVEN ON PLATE NO. 9.
6. BASELINE AND STATIONS SHOWN APPLI
   CROSS SECTIONS OF PROPOSED DISPOS
   SCHEMES ON PLATE NO. 13, 14, 15,
7. TOPOGRAPHY SHOWN IS BASED ON OCT
   AERIAL FLIGHT.

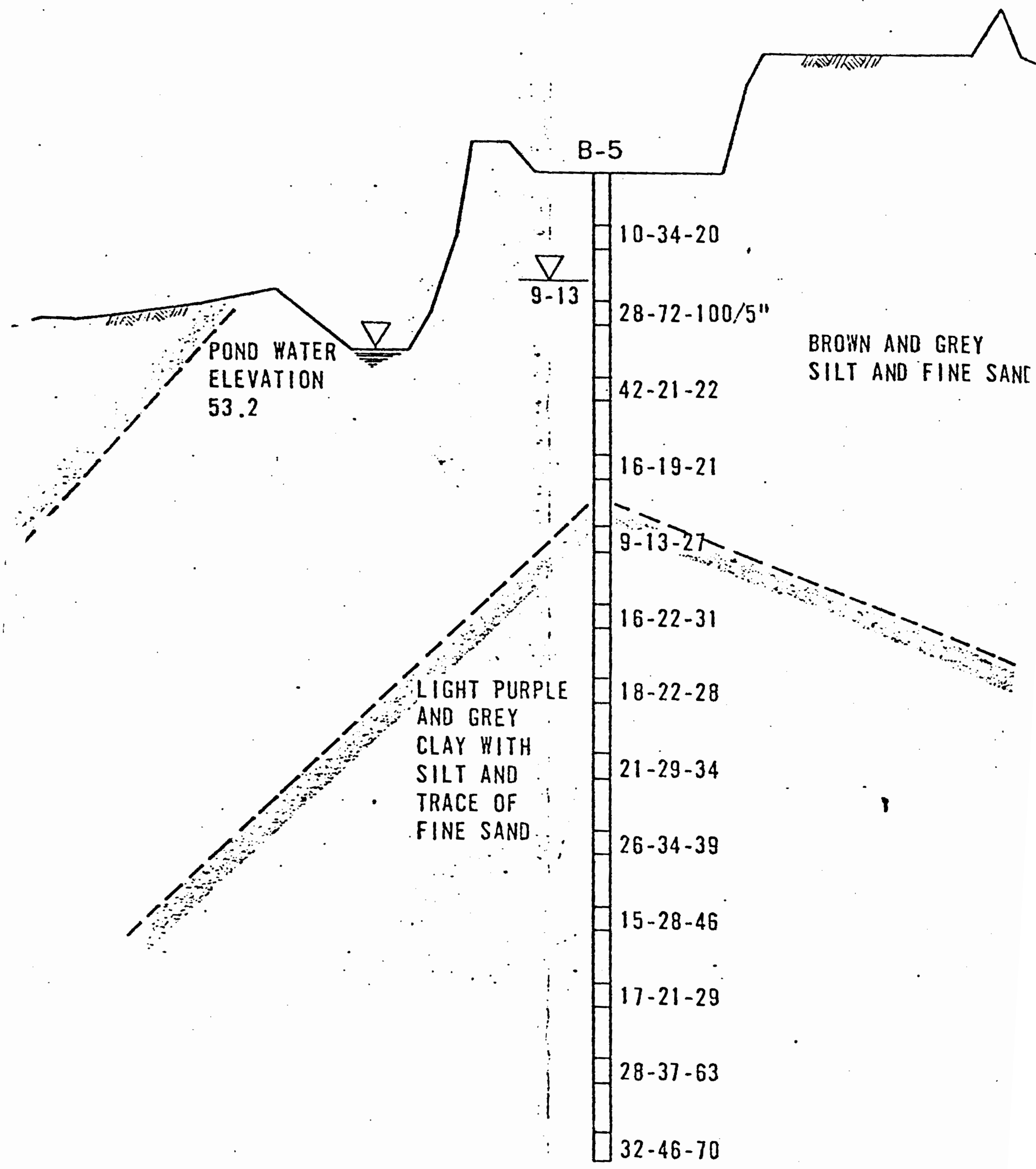
MCA ENGINEERING CORP.
CONSULTING ENGINEERS
BALTIMORE, MARYLAND

QUAR
TES
SCALE



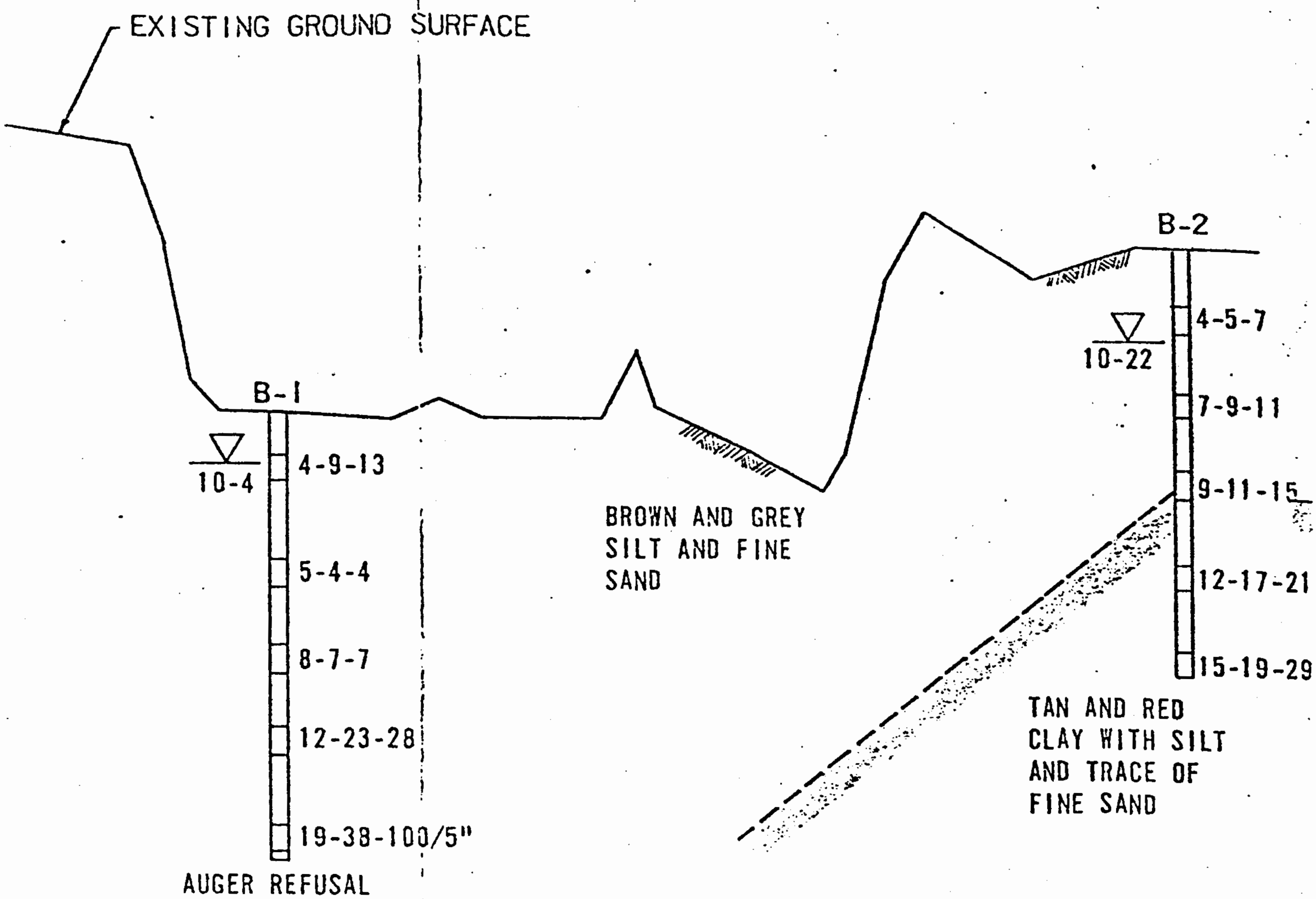
Ref: MCA Report
Boring Profile A-A
Plate No. 4

SEE PLATE NO. 3 FOR GENERAL NOTES.



Ref: MCA Report
Boring Profile
Plate No. 4

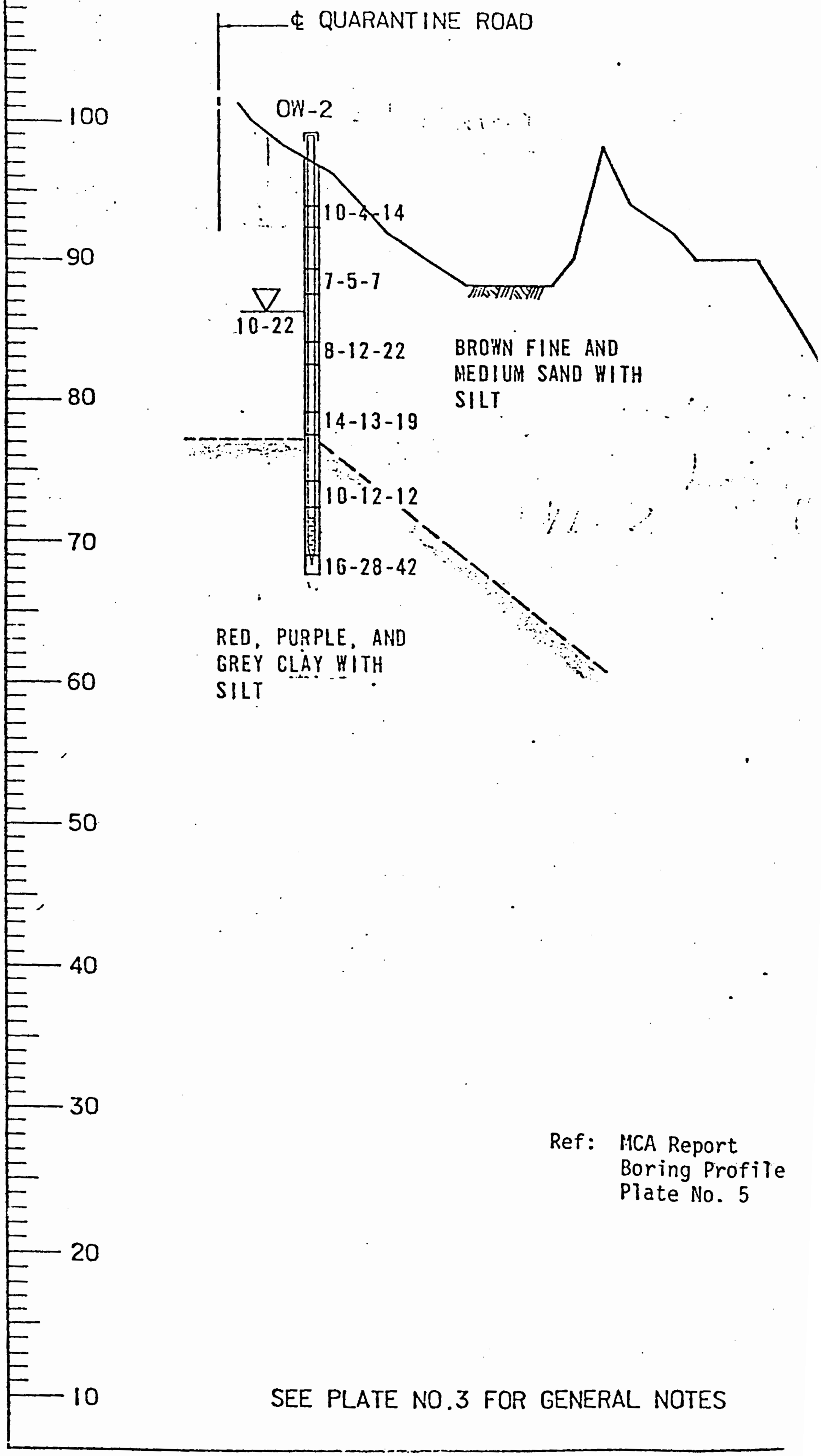
GENERAL NOTES.



MCA ENG
CONSUL
BALTIM

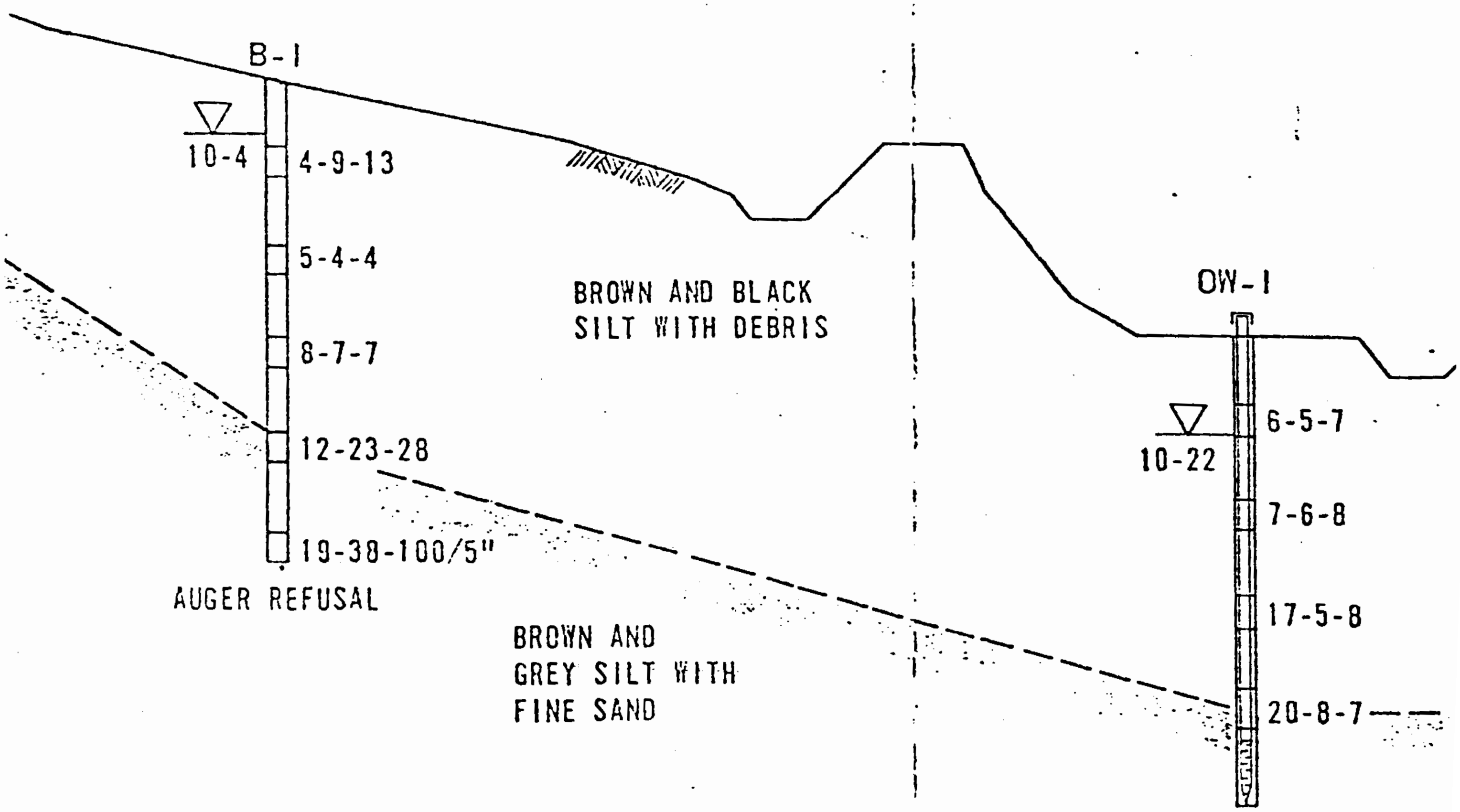
Ref: MCA Report
Boring Profile
A-A
Plate No. 4

P
QUARANTI
BORING
SCALE: H. 1"
V. 1"

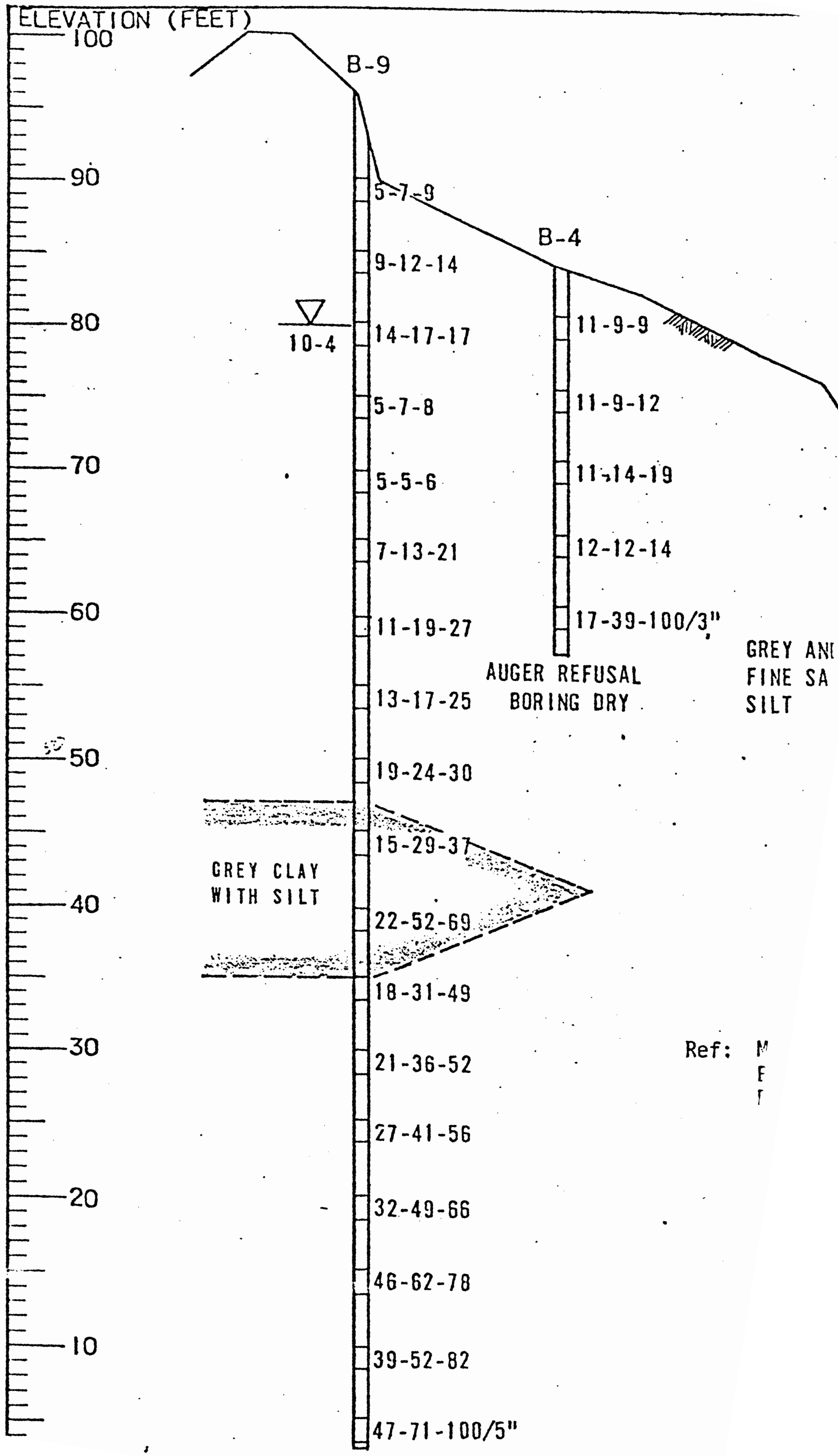


Ref: MCA Report
Boring Profile
Plate No. 5

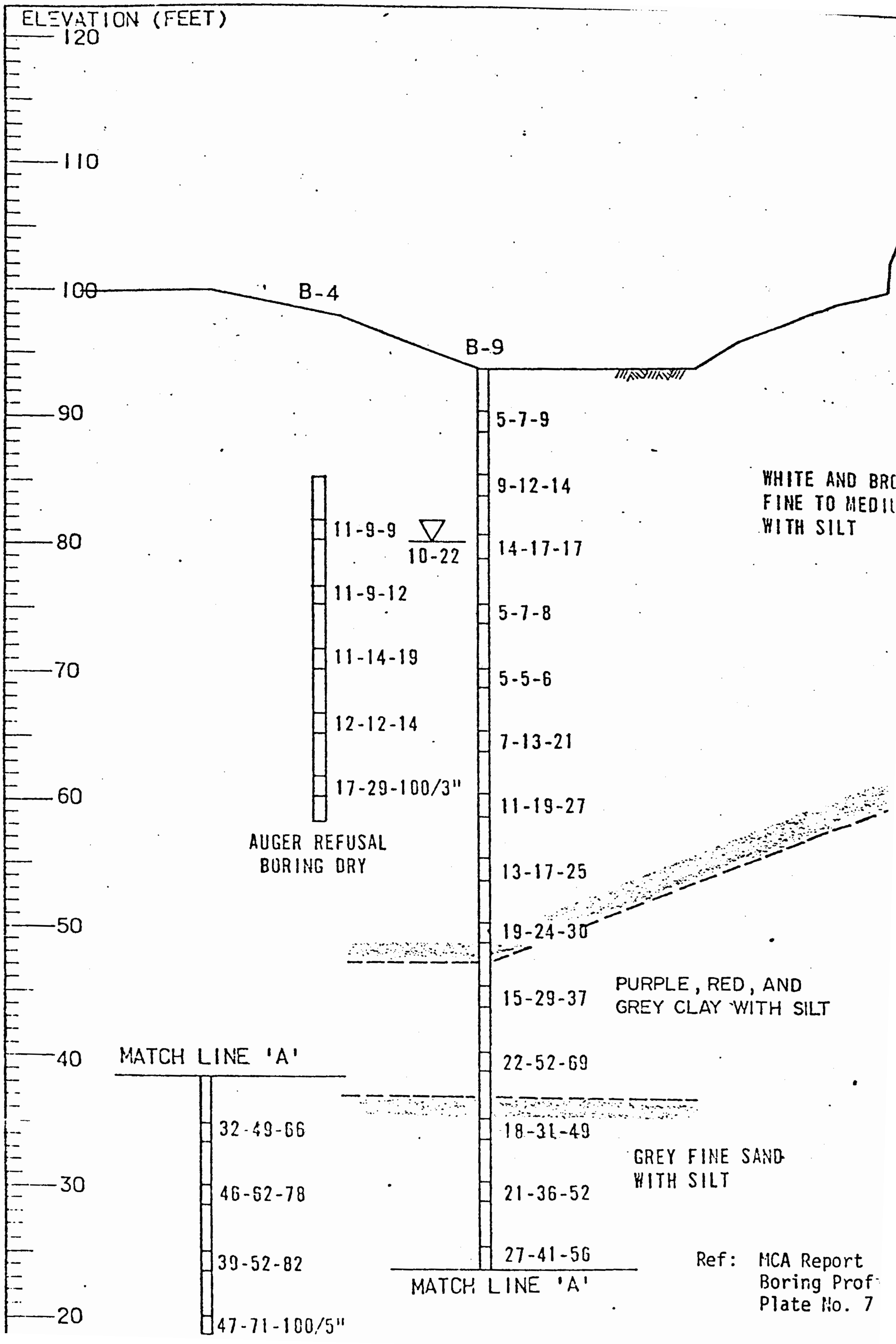
SEE PLATE NO.3 FOR GENERAL NOTES



Ref: MCA Report
Boring Profile B-B
Plate No. 5

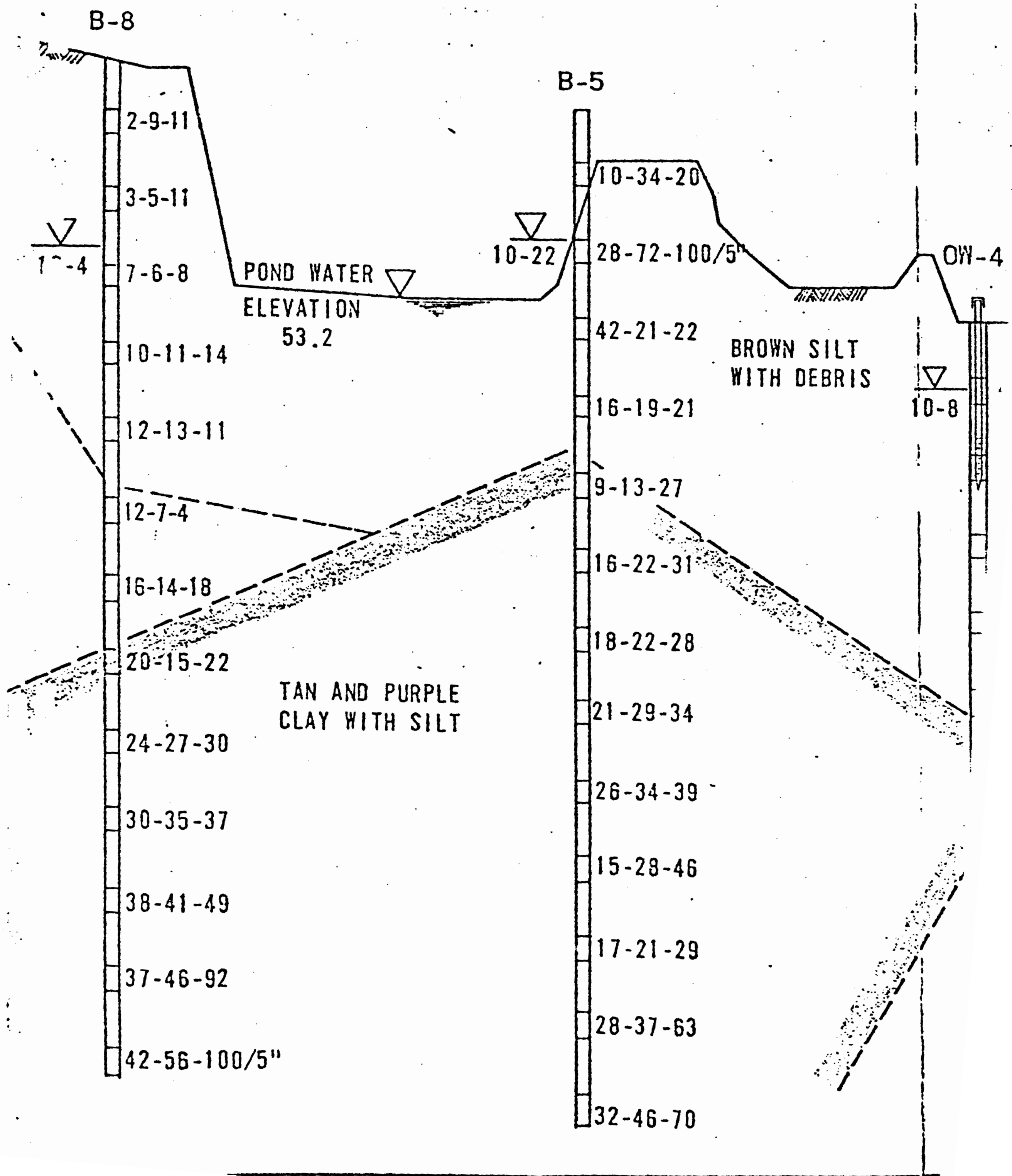


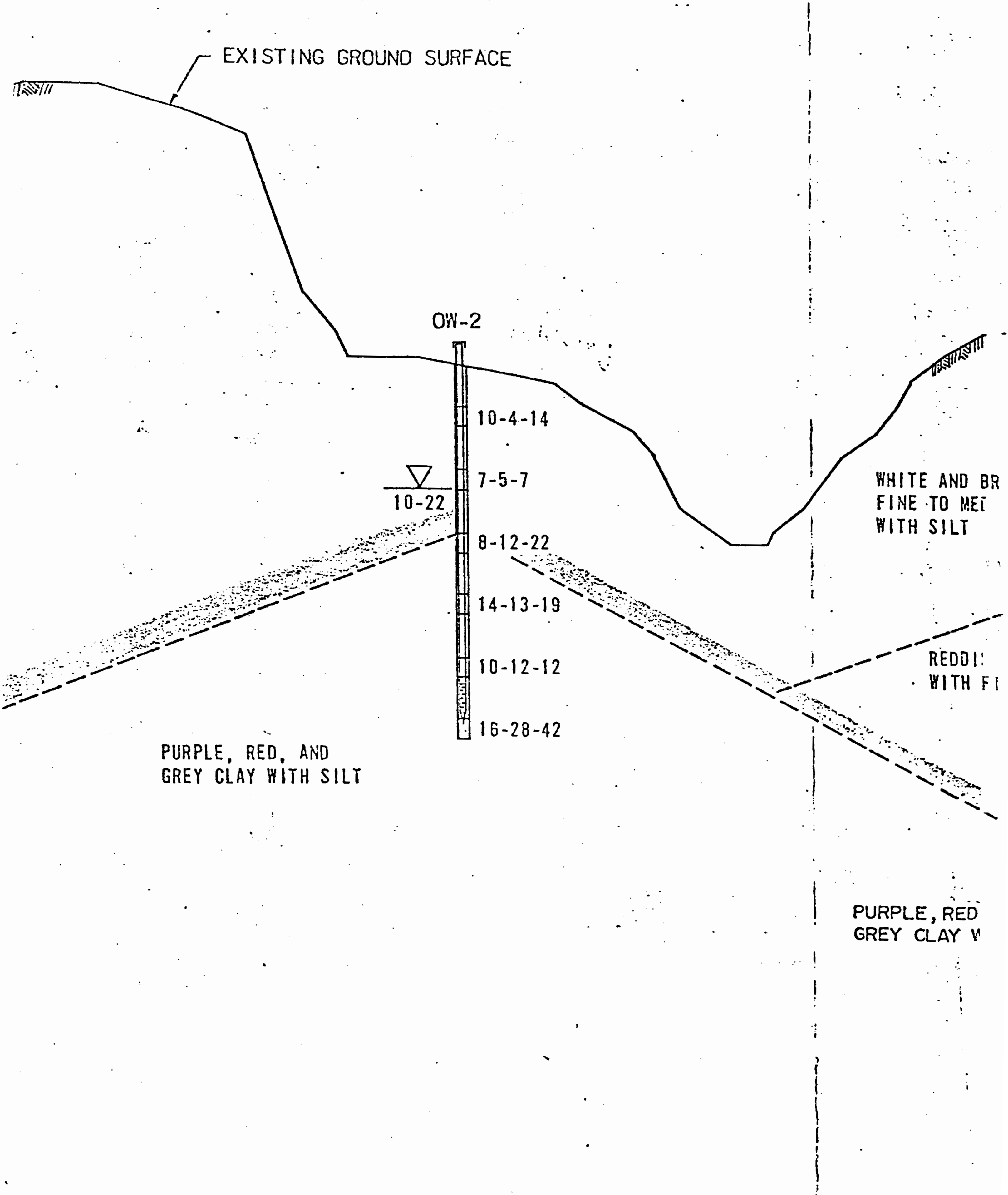
ELEVATION (FEET)
100
90
80
70
60
50
40
30
20
10
B-9
5-7-9
9-12-14
10-4
14-17-17
5-7-8
5-5-6
7-13-21
11-19-27
13-17-25
19-24-30
15-29-37
GREY CLAY
WITH SILT
22-52-69
18-31-49
21-36-52
27-41-56
32-49-66
46-62-78
39-52-82
47-71-100/5"
B-4
11-9-9
11-9-12
11-14-19
12-12-14
17-39-100/3"
AUGER REFUSAL
BORING DRY
GREY AN
FINE SA
SILT
Ref:



Ref: MCA Report
Boring Prof
Plate No. 7

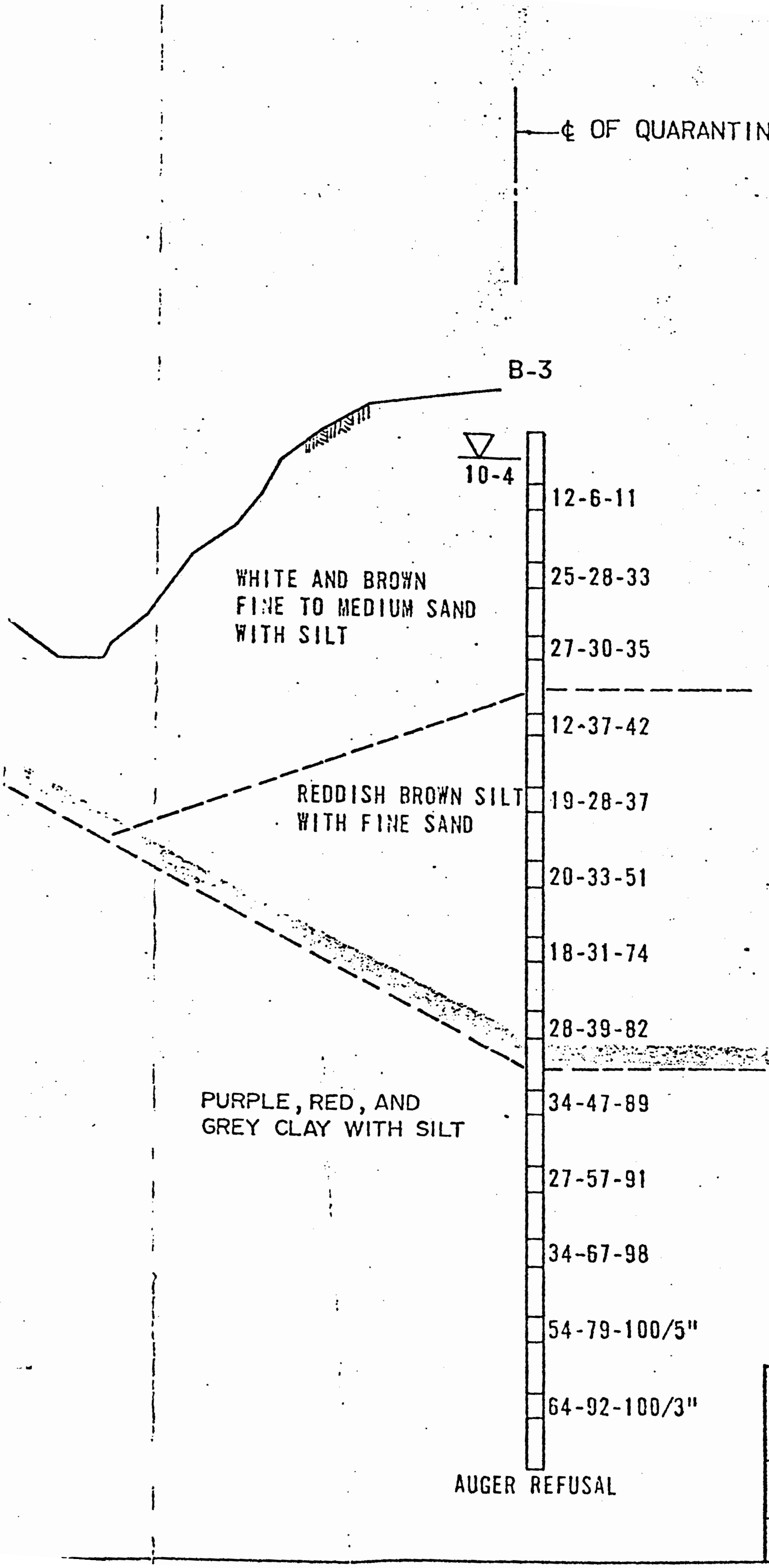
Ref: MCA Report
Boring Profile
Plate No. 6





SEE PLATE NO.3 FOR GENERAL NOTES.

Ref: MCA Report
Boring Profile D
Plate No. 7



Ref: MCA Repo
Boring P
Plate Nc

MCA ENGINEERIN(
CONSULTING ENC
BALTIMORE, MA

PROPOSED QUARANTINE ROAD
BORING PROFILE
SCALE: H. 1" = 100' V. 1" = 10'

TEST BORING	DEPTH BELOW GROUND SURFACE (FT)	NATURAL WATER CONTENT	% PASSING # NO.200 SIEVE	ATTERBERG LIMITS
B-1	23.5 - 25.0	48%	85%	-
B-3	23.5 - 25.0 48.5 - 50.0	13% 17%	60% 86%	- Liquid Limit = Plasticity Index =
B-4	8.5 - 10.0 23.5 - 25.0	15% 12%	81% 82%	- -
B-5	18.5 - 20.0 28.5 - 30.0 48.5 - 50.0 58.5 - 60.0	16% 17% 16% -	56% 91% - -	- - - Liquid Limit = Plasticity Index =
B-6	23.5 - 25.0 38.5 - 40.0	- -	- -	Liquid Limit : Plasticity Index : Liquid Limit : Plasticity Index :
B-8	28.5 - 30.0 43.5 - 45.0	24% 18%	24% 99%	- -
B-9	23.5 - 25.0 48.5 - 50.0 53.5 - 55.0 73.5 - 75.0 88.5 - 90.0	17% - 17% 15% 12%	84% - 78% 66% 37%	- Liquid Limit Plasticity Index - - -
B-10	3.5 - 5.0 8.5 - 10.0 13.5 - 15.0	11% 15% 15%	68% 81% 89%	- - -
OW-1	18.5 - 20.0	22%	65%	-
OW-2	18.5 - 20.0 28.5 - 30.0	15% -	76% -	- Liquid Limit Plasticity Index
OW-4	28.5 - 30.0 38.5 - 40.0	17% 16%	79% 86%	-

LABORATORY TEST RESULTS | PLA

TEST BORING	GROUND SURFACE ELEV. (FT.)	COMPLETION DATE	GROUNDWATER ELEVATION (FT.)					
			@ CMPLTN.	10-4	10-7	10-8	10-12	10-22
B-1	52.2	9-14	49.2	49.2	Note 1	-	-	-
B-2	62.9	10-12	54.9	-	-	-	-	57.7
B-3	92.1	9-17	85.6	91.7	-	-	-	90.6
B-4	85.4	10-4	Dry to 27'	-	Dry to 19'	-	-	Note 1
B-5	65.5	9-13	57.1	-	-	-	-	53.8
B-6	64.1	10-5	60.1	-	-	-	-	61.5
B-7	--	10-7	Dry to 18'	-	-	-	-	
B-8	69.0	9-27	61.2	57.6	-	-	-	54.7
B-9	93.2	9-28	68.7	80.4	-	-	-	80.0
B-10	82.4	10-6	74.6	-	-	-	-	74.4
OW-1	40.6	9-30	18.0	35.0	-	35.0	-	35.9
OW-2	96.9	10-4	72.7	-	-	84.3	-	86.4
OW-3	46.7	10-7	38.2	-	-	-	-	42.5
OW-4	53.2	10-6	Note 2	-	-	48.8	48.3	48.7

NOTE 1: TEST BORING BACK FILLED BY OTHERS.
NOTE 2: OBSERVATION WELL DRY AT COMPLETION.

GROUNDWATER MEASUREMENTS

PLATE NO. 9

STATE OF MARYLAND

WATER RESOURCES ADMINISTRATION

TEST BORING DATA

The attached data represent information exerpted from the WRA report entitled, A Hydrogeologic Investigation of the Hawkins Point Chrome Ore Tailings Disposal Site, prepared by R. R. Steimle (December, 1977).

GB-73-C

STATE OF MARYLAND
WATER RESOURCES ADMINISTRATION
GROUNDWATER MANAGEMENT DIVISION

BORING LOG

SHEET ___

Location Maryland Port Administration BORING NO. 6

as Point Chrome Tailing Disposal Site SURFACE ELEVATION 22'

DATE STARTED 10/19/77

DATE COMPLETED 10/19/77

DRILLER Filar

RIG NO. CME-45

HAMMER DROP

DRIVE HAMMER

SPOON HAMMER

CASING SIZE

SPOON SIZE

SIZE OF CORE

SIZE OF BIT

CORE BARREL

6" O.D.Continuo

WATER TABLE

DEPTH BELOW SURFACE	TIME	DATE
4.5	immed.	10/19/77
4.0	10:10am	10/26/77

Depth in Feet	MATERIAL CLASSIFICATION	SPOON SAMPLE #	SPOON BLOWS	SPOON DEPTH	Rock Core Recovery %	REMARKS
0.0 – 7.0	Red/Brown CLAY with Trace PEA GRAVEL — Dry	N.S				
7.0 – 10.0	Tan Medium CLAY Sand with Trace GRAVEL Pea to ½" — Moist	N.S				Wet at 9'
10.0 – 15.0	Tan Medium SAND and Fines — Liquified	N.S				
15.0 – 24.5	Coarse Grey SAND and Fines — Liquified	N.S				

GW-72-5

STATE OF MARYLAND
WATER RESOURCES ADMINISTRATION
GROUNDWATER MANAGEMENT DIVISION

BORING LOG

SHEET ______ OF ______

Location Maryland Port Administration
ins Point Chrome Tailing Disposal Site
tion 5 + 10 110' Rt. Baseline

BORING NO. 14
SURFACE ELEVATION 37'
DATE STARTED 10/21/77
DATE COMPLETED 10/21/77
DRILLER Filar
RIG NO. AD-II

HAMMER DROP N/A
DRIVE HAMMER N/A
SPOON HAMMER N/A
CASING SIZE N/A
SPOON SIZE N/A
SIZE OF CORE N/A
SIZE OF BIT N/A
CORE BARREL TYPE N/A

6" O.D. Continuous Flight Aug

WATER TABLE

DEPTH BELOW SURFACE	TIME	DATE
15.0	immed.	10/21/77
15.0	3 p.m.	10/21/77

Depth in Feet	MATERIAL CLASSIFICATION	SPOON SAMPLE #	SPOON BLOWS	SPOON DEPTH	Rock Core Recovery %	REMARKS
0.0	Red/White CLAY	N.S				
13.0	Dry					
	CHROME ORE	N.S				Wet at 20'
22.0	Moist					Liquid at 22'
	Red CLAY	N.S				
4.0	Dry					

DEPTH	Casing Blows Per Foot
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
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52	
53	
54	

GW-72-5

STATE OF MARYLAND
WATER RESOURCES ADMINISTRATION
GROUNDWATER MANAGEMENT DIVISION

BORING LOG

SHEET ______ OF ______

Location Maryland Port Administration — BORING NO. 15
n Point Chrome Tailing Disposal Site — SURFACE ELEVATION 37'
ation 5 + 10 25' L Baseline
DATE STARTED 10/21/77
DATE COMPLETED 10/21/77
DRILLER Feheley
RIG NO. AD-II

HAMMER DROP N/A IN.
DRIVE HAMMER N/A LB.
SPOON HAMMER N/A LB.
CASING SIZE N/A IN.
SPOON SIZE N/A IN.
SIZE OF CORE N/A IN.
SIZE OF BIT N/A
CORE BARREL TYPE N/A

6" O.D. Continuous Flight Augers

WATER TABLE

DEPTH BELOW SURFACE	TIME	DATE
14.0	immed.	10/21/77
14.0	9 a.m.	10/24/77

Depth in Feet	MATERIAL CLASSIFICATION	SPOON SAMPLE #	SPOON BLOWS	SPOON DEPTH	Rock Core Recovery %	REMARKS
0	Red/White CLAY	N.S				
13.0	Dry					
	CHROME ORE	N.S				Wet at 15.0
[illegible].0	Moist					Liquid at 21.0
	Red CLAY	N.S				
[illegible].0	Dry					

DEPTH	Casing Blows Per Foot
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
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53	
54	

<u>STATE HIGHWAY ADMINISTRATION</u>

<u>TEST BORING DATA</u>

The attached data represent information obtained from the State Roads Commission <u>Baltimore Harbor Outer Crossing Master Soils Plan and Profile</u> "Curtis Creek to Crossing - Baltimore City"

STATE HIGHWAY ADMINISTRATION BORINGS USED FOR QUARANTINE ROAD SANITARY LANDFILL EVALUATION *

BORING	STRATA NO.	FROM/TO	MD. SRC/AASHO CLASSIFICATION	GENERAL DES(
L-046	1	0.0/0.5	Topsoil	Topsoil
	2	0.5/6.5	A-2-4/A-2-4	Silty sand
	3	6.5/17.0	A-4-2/A-4(0)	Sandy silt
	4	17.0/22.0	A-4-2/A-2-4	Sandy silt
L-048	1	0.0/7.0	A-4-7/A-4	Clayey silt
	2	7.0/12.0	A-2-4/A-2-4	Silty sand
	3	12.0/18.0	A-4-7/A-4	Clayey silt
	4	18.0/31.0	A-3/A-3	Sand to san
A-050	1	0.0/0.1	Topsoil	Topsoil
	2	0.1/10.0	A-4-7/A-4	Clayey silt
4L-055	1	0.0/3.0	A-4/A-4	Silt to si
	2	3.0/8.0	A-4/A-4	Silt to si
	3	8.0/12.0	A-4-2/A-2-4	Sandy silt
	4	12.0/15.0	A-7/A-7-6	Clay to co
W-067	1	0.0/7.0	Water	Water
	2	7.0/8.5	Green Crystals	Green Crys
	3	8.5/13.0	A-4/A-4	Silt to si
	4	13.0/17.0	A-2-4/A-1-b	Silty sand
	5	17.0/25.0	A-4-7/A-4(1)	Clayey sil

STATE HIGHWAY ADMINISTRATION BORINGS USED FOR
QUARANTINE ROAD SANITARY LANDFILL EVALUATION

BORING	STRATA NO.	FROM/TO	MD.SRC/AASHO CLASSIFICATION	GENERAL DESCRIPTION
4L-085	1	0.0/0.5	Topsoil	Topsoil
	2	0.5/3.0	A-4/A-4	Silt to silt
	3	3.0/7.0	A-4/A-4	Silt to silt
	4	7.0/18.0	A-4/A-4	Silt to silt
	5	18.0/20.0	A-4-7/A-4	Clayey silt to silt
4L-100	1	0.0/3.0	A-4/A-4	Silt to silt
	2	3.0/20.0	A-7/A-6	Clay to colloidal cl
4L-0385	1	0.0/3.0	A-2-4/A-2-4	Silty sand to silty
	2	3.0/6.0	A-7/A-6	Clay to colloidal c
	3	6.0/13.0	A-4/A-4	Silt to silt
	4	13.0/17.5	A-4/A-4	Silt to silt
	5	17.5/22.0	A-3/A-3	Sand to sand
	6	22.0/28.0	A-4-2/A-2-4	Sandy silt to silty
	7	28.0/31.0	A-4-2/A-2-4	Sandy silt to silty
	8	31.0/36.0	A-4-7/A-4	clayey silt to silt
	9	36.0/43.0	A-4-7/A-4	Clayey silt to silt
	10	43.0/47.0	A-2-4/A-2-4	Sandy silt to sand
	11	47.0/56.0	A-2-4/A-1-b(0)	Silty sand to grave
	12	56.0/70	A-4/A-4	Silt to silt

STATE HIGHWAY ADMINISTRATION BORINGS USED FOR

QUARANTINE ROAD SANITARY LANDFILL EVALUATION

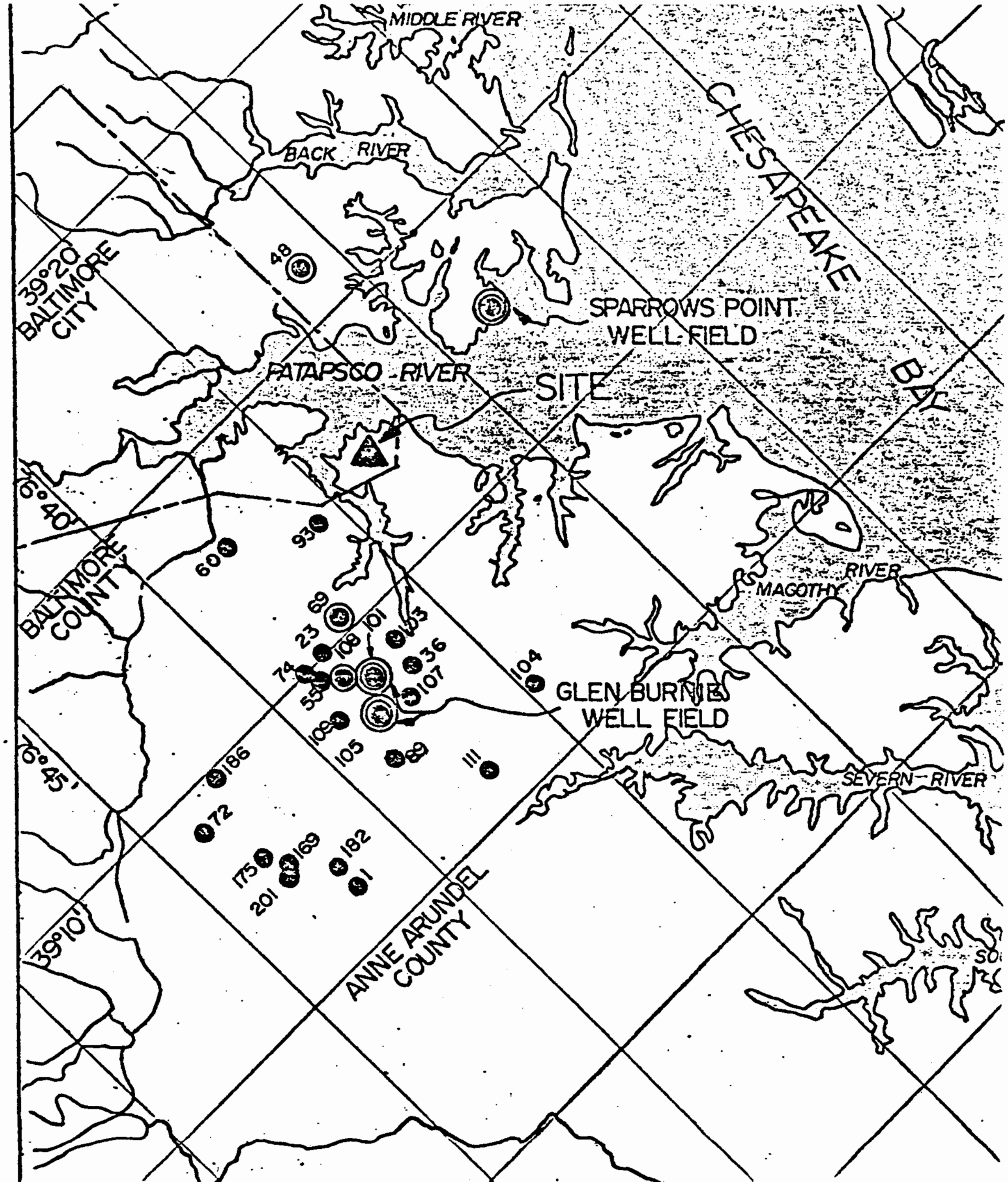
BORING	STRATA NO.	FROM/TO	MD. SRC/AASHO CLASSIFICATION	GENERAL DESCRIPTION
L-220	1	0.0/8.0	A-2-4/A-1-b(0)	Silty sand to gravel
	2	8.0/16.0	A-4/A-4	Silt to silt
	3	16.0/21.0	A-4-2/A-4	Sandy silt to silt
	4	21.0/40.0	A-6/A-7-6	Colloidal clay to colloidal clay
	5	40.0/50.0	A-4-7/A-6	Clayey silt to colloidal clay

* Source: State of Maryland, State Roads Commission; Baltimore Harbor Outer Crossing Master Soils Plan and Profile "Curtis Creek to Crossing - Baltimore City"

APPENDIX C

PRODUCTION WELL DATA

Exhibit 1	-	Patapsco Aquifer Wells
Exhibit 2	-	Patuxent Aquifer Wells
Exhibit 3	-	Principal Water-Bearing Zones and Confining Beds



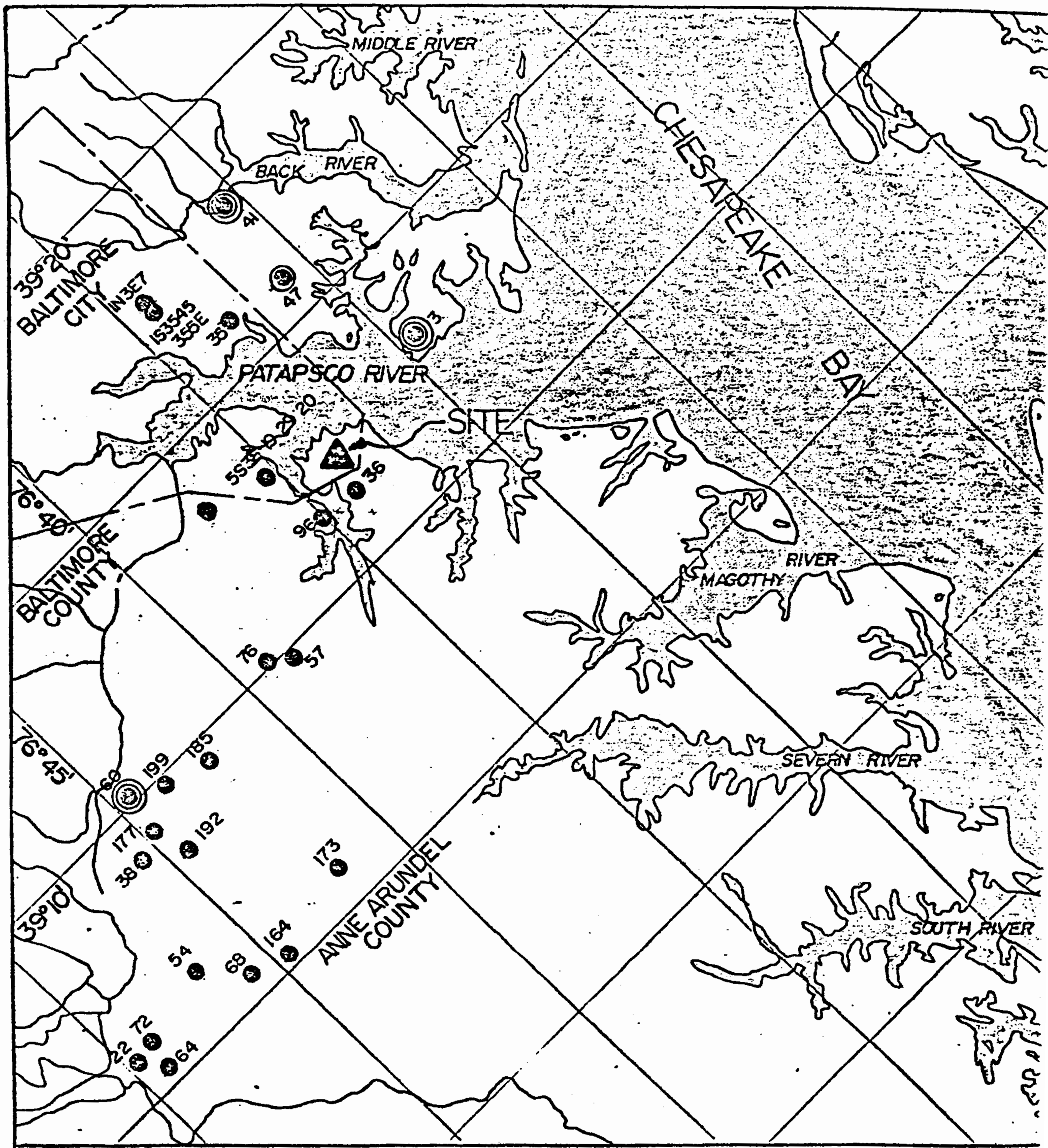
LEGEND

- WELLS PRODUCING ≥ 1.0 MGD.
- WELLS PRODUCING ≥ 0.1 MGD. ≤ 1.0 MGD.
- WELLS PRODUCING > 1.0 MGD.

ROBB TYLE.
SUBSIDIARY
BROWNING-FERRIS
QUARANTINE ROA
LANDF

PATAPSCO AQUIF

DATE: JAN 1979 EXHIBIT I
HARRINGTON, LACEY & A
ENGINEER



LEGEND

- WELLS PRODUCING ≥ 1.0 MGD.
- WELLS PRODUCING ≥ 0.1 MGD ≤ 1.0 MGD.
- WELLS PRODUCING > 1.0 MGD.

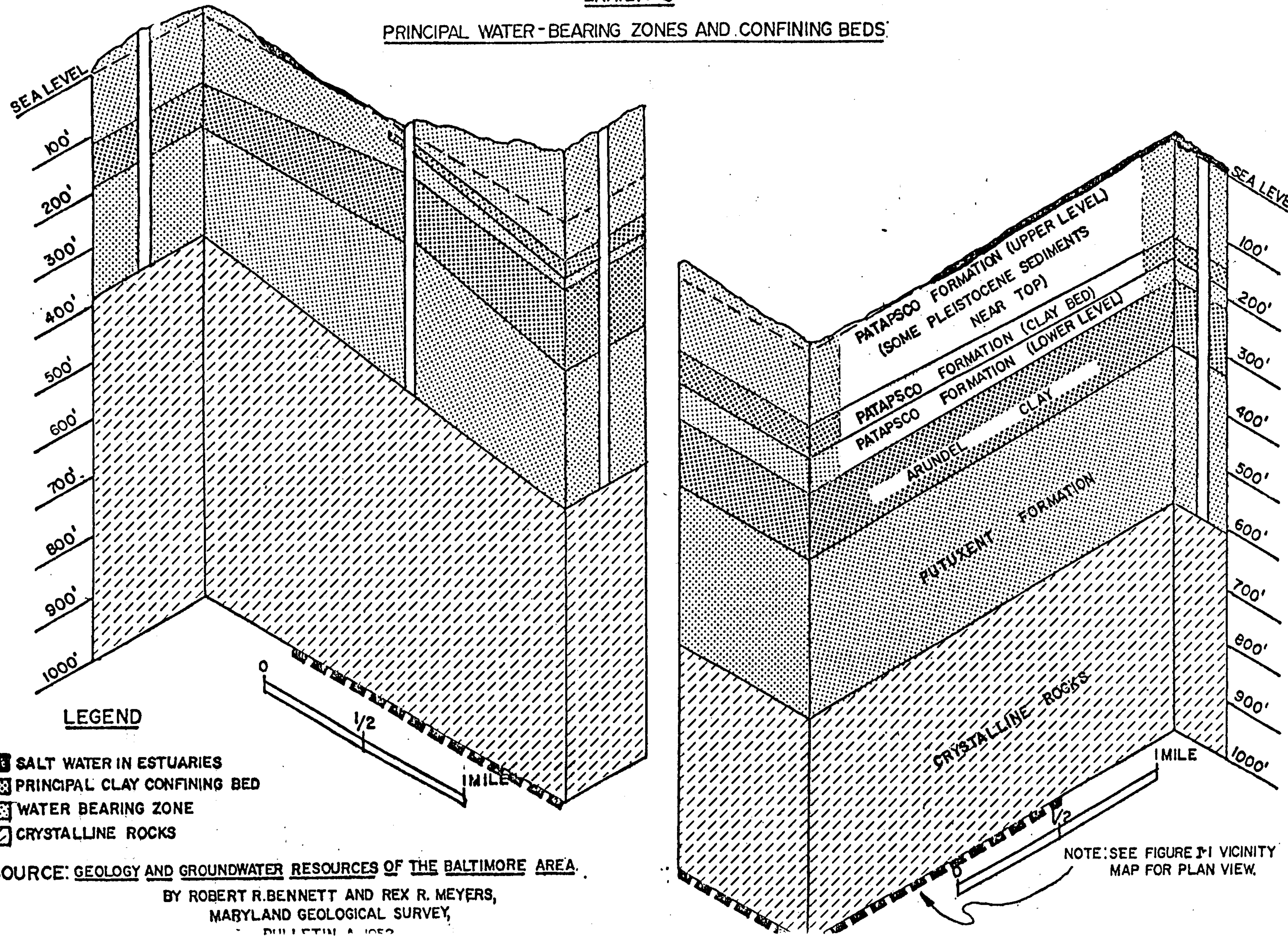
ROBB TYLER INC.
SUBSIDIARY OF
BROWNING-FERRIS INDUSTRIE
QUARANTINE ROAD SANIT
LANDFILL

PUTUXENT AQUIFER W

DATE: JAN 1979 EXHIBIT 2 SCALE: 1"
HARRINGTON, LACEY & ASSOCIATES

EXHIBIT 3

PRINCIPAL WATER-BEARING ZONES AND CONFINING BEDS



LEGEND

- SALT WATER IN ESTUARIES
- PRINCIPAL CLAY CONFINING BED
- WATER BEARING ZONE
- CRYSTALLINE ROCKS

NOTE: SEE FIGURE I-1 VICINITY MAP FOR PLAN VIEW.

SOURCE: GEOLOGY AND GROUNDWATER RESOURCES OF THE BALTIMORE AREA.
BY ROBERT R. BENNETT AND REX R. MEYERS,
MARYLAND GEOLOGICAL SURVEY,
BULLETIN 4, 1952

APPENDIX D

DESIGN RATIONALE COMPUTATIONS

AND

WATER BALANCE COMPUTATION INSTRUCTIONS

INSTRUCTIONS FOR COMPUTING PERCOLATION USING THE WATER BALANCE METHOD (MONTHLY)

1. Obtain precipitation and temperature records for nearest station to site being evaluated. These figures should then be adjusted to monthly normal:

2. Using Thornthwaite's charts (Tables 1 & 2) of monthly values of i (heat ind corresponding to monthly mean temperatures, select an i value for each month. These values should be accumulated to obtain a yearly I value.

3. Using the yearly I value and the monthly temperatures, obtain the monthly unadjusted P.E.T. (Potential Evapotransporation) from Thornthwaite's Tables (Tables 3, 4 & 5).

4. Determine the latitude of the subject site and go to Tables 6 thru 9. Selec mean possible monthly duration of sunlight factor for each month.

5. Multiply unadjusted P.E.T. for each month by its corresponding duration sunlight factor to obtain adjusted P.E.T.

6. Enter adjusted P.E.T. on appropriate line of water balance data form. Enter monthly precipitation (P) on form.

7. Select a C factor for the site. Multiply C factor by precipitation to obtai runoff (R/O).

8. Subtract runoff from precipitation to obtain I (infiltration).

9. Subtract P.E.T. from I to obtain I-P.E.T. These may be either positiv or negative values.

10. Accumulate I-P.E.T. values and note if the total is a positive or negati value. If the total is positive, enter 0 in the Σ - (I-P.E.T.) column for last month with a positive I-P.E.T. Begin accumulation of negative I-P from next (first negative) I-P.E.T. value. The storage value (ST) for last month with a positive I-P.E.T. will be the field capacity of the soil Use Thornthwaite's Table of soil moisture retention (Tables 11 thru 22) selected field capacity of the soil to obtain ST values. Enter the Table monthly Σ - (I-P.E.T.) to obtain monthly value. When there is a posi I-P.E.T. between two negative I-P.E.T.'s, ST is found by direct addit of I-P.E.T. to the preceeding ST. The Σ - (I-P.E.T.) is then found b entering the soil moisture retention Table with the resulting ST.

    When the accumulated yearly I-P.E.T. is negative, you must use Tho successive approximation method to determine the Σ - (I-P.E.T.) witl to begin the accumulation. (See "Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance", by C.W. Thornthw and J. R. Mather, Drexel Institute of Technology Publications in Climat

11. Subtract ST from previous ST to obtain ΔST for each month.

12. AET (Actual Evapotranspiration) is obtained by using the formula AET = + [(I-P.E.T.) - ΔST] (AET = P.E.T. when I-P.E.T. is positive).

13. Percolation (Perc.) is obtained with the formula Perc. = P-R/O -ΔST -

SECURE LANDFILL DESIGN RATIONALE COMPUTATION

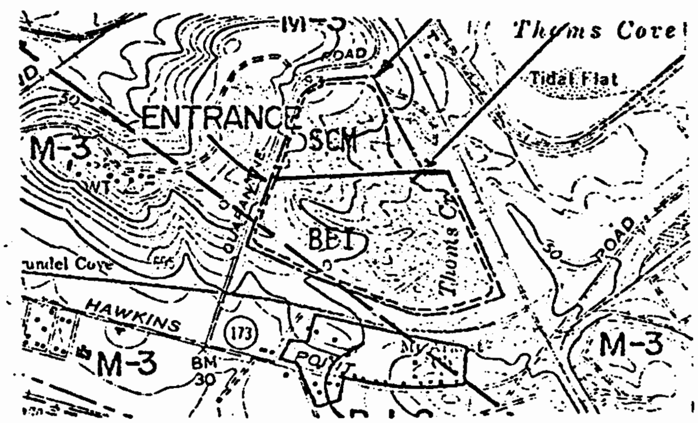
A. BASIS

1. The proposed landfill site consists of land that was previous used as an uncontrolled dump site for all types of solid wast including some liquids and semi-solids.

2. Previous drainage conditions permitted the mixing of off-site surface runoff; on-site surface runoff; surface water; and on-site surface leachate.

3. A recently terminated landfill operation existed on the BFI t as an extension of the former uncontrolled solid waste fill operation. Miscellaneous piles of dumped materials exist on the SCM tract along with undisturbed areas.

4. Existing barriers at the site boundaries must be considered the design of the site: B & O railway along eastern limit; Quarantine Road along the northern and western limit; Inters and BFI, along the southern limit.



5. Water Resources Administration (WRA) has documented an exis potential leachate problem apparently caused by previous im disposal practices.

6. The landfill design will improve and/or correct the site's surface water drainage system to provide for surface runoff leachate control.

7. The landfill design will minimize infiltration from direct cipitation and from surface water runoff in order to minimi leachate generation.

8. The landfill design will not allow waste disposal in surfac water or ground water. A clay buffer zone and a clay barrie will be provided between the base of the landfilled waste ar seasonal high groundwater table on the newly excavated fill

9. The facility design will include a leachate collection and treatment system that will control the existing potential leachate problem and minimize the potential for future leachate due to the ongoing landfill operation.

10. Discharges into the surface waters will be in accordance with the National Pollutant Discharge Elimination System (NPDES) Permit limitations.

11. Leachate may be generated by infiltration and the decomposition of the wastes. Moisture within the landfill will be contributed to by the moisture content of the solid waste; precipitation that falls directly on the exposed working face; and infiltration.

12. A combination of natural and man-made clay barriers and the leachate collection system will minimize the potential for leachate to leave the site. The landfill must reach field capacity before leachates will leave the site. Small, isolated pockets within the landfill may reach field capacity as the result of short circuiting of infiltrate, and small amounts of leachate may break out at the side slopes. The leachate collection system will divert leachate to the leachate collection system for final treatment.

13. Some measure of pollutant attenuation will be provided by the clayey sediments which underlie the site. Hence, leachates that may percolate below the landfill will be controlled by the natural soil attenuation and soil renovation mechanisms of the underlying buffer zone.

B. LEACHATE QUANTITY ESTIMATE

1. The U.S. Environmental Protection Agency (EPA) Water Balance Method has been used to estimate the amount of leachate that must be ultimately controlled at the Quarantine Road DHS Fill. (Ref: EPA/530/SW-168, Oct. 1975 entitled, Use of the Water Balance Method for Predictin Leachate Generation from Solid Waste Disposal Sites). The Water Balance Method is an acceptable leachate generation estimating technique.

2. In order to compute the Water Balance, precipitation and temperature data must be determined. Also, a surface runoff coefficient must be selected. The publication entitled, Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance, by C.W. Thornthwaite and J.R. Mather (Drexel Institute of Technology, Laboratory of Climatology, "Publications in Climatology, Vol. x, No. 3", 3rd Printing, Centerton, New Jersye, 1957) must be referred to for empirical data and special case instructions.

a. "Normal" precipitation and temperature data were used to estimate future leachate generation. The "normal" data were obtained from the reported records of the Baltimore WSO, CI station located approximately 1.7 miles northwest of the site. (Ref: Climatological Data, for Maryland and Delaware, Vol. 77, No. 12 (Dec. 1973) through Vol. 78, No. 11 (Nov. 1974) published by the U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Temperature and Precipitation Tables).

Normal Temperature Data (^{o}F)

J	F	M	A	M	J	J	A	S	O	N	
36.1	37.4	45.1	56.4	66.3	75.1	79.4	77.6	77.1	60.7	48.8	39

Normal Precipitation Data (in.)

J	F	M	A	M	J	J	A	S	O	N	
3.00	2.92	3.80	3.23	3.63	3.84	4.12	4.01	3.25	2.86	3.10	3.

Annual Normal Precipitation = 40.92 inches
x 25.4 = 1039.37, say 1C

b. Surface Water Runoff Coefficient - The surface runoff coefficient used for computing the Water Balance is 0.30 for each month of the calendar year. Freezing temperatures during the winter months will increase the runoff coefficient. The Baltimore City Manual of Design Procedure and Criteria (1972) does not include adequate runoff coefficient data for undeveloped lands or for fill type developments. The Baltimore County Design Manual (selected as an alternative reference due to similar geography) includes "Table A - Runoff Coefficients for Various Surfaces and Slopes" and 0.30 was selected as a reasonable design value because:

(1) for clay soils with slopes ≥ 7.1%, the coefficient for lawns and sparse vegetation ranges between 0.30 and .70 respectively.

(2) for sandy soils with slopes ≥ 7.1%, the coefficient for lawns and sparse vegetation ranges between .17 and .40 respectively.

The EPA Water Balance publication includes Table 3 entitled, "Runoff Coefficients" which they obtained from the publication Handbook of Applied Hydrology; A Compendium of Water Resources Technology, V. T. Chow

(New York: McGraw-Hill, 1964). In that publication Table 3 indicates runoff coefficients for heavy soil, steep 7% slopes, ranging between 0.25 and 0.35.

The site's sediments have been classified according to the Unified Soil Classification System wherein the materials vary within the range between poorly graded sands (SP) and silts and clays having low to medium plasticity (ML - CL).

Due to the inherent characteristics of cover material excavation, stockpiling, transportation, and application, the sediments will be mixed as part of the landfill operation. In general, the sediment analysis indicates that the sediments have a high clay content and can be considered heavy.

c. Water Balance Computation - The computation requires the use of a value for potential evapotranspiration (PET). This value is found by computation according to the instructions included in the previously referenced publication by Thornthwaite and Mather. Normal temperature values were used:

PET Computation:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Normal Temp. °F	36.1	37.4	45.1	56.4	66.3	75.1	79.4	77.6	71.1	60.7	48.8	39.0
Heat Index	.30	.46	1.76	4.52	7.58	10.71	12.37	11.66	9.24	5.79	2.57	.68
Unadjust. PET	.00	.00	.02	.06	.11	.15	.18	.17	.13	.08	.04	.01
(multiplied by)	x	x	x	x	x	x	x	x	x	x	x	x
39° Lat. Adjust.	25.5	25.2	30.9	33.3	36.9	37.2	37.8	35.4	31.2	28.8	25.2	24.6
(equals)	=	=	=	=	=	=	=	=	=	=	=	=
PET (in.)	0	0	.6	2.0	4.1	5.6	6.8	6.0	4.1	2.3	1.0	.2
(x 25.4)PET (mm)	0	0	15.2	50.8	104.1	142.2	172.7	152.4	104.1	58.4	25.4	5.1

The Water Balance for the Quarantine Road DHS fill site is computed on sheet 5. The following notes represent site specific data required for the water balance computation.

(1) Normal temperature determined from climatological data.
(2) Heat Index from Thornthwaite Table 1.
(3) Unadjusted PET from Thornthwaite Table 3.
(4) PET adjustment is 39° N. latitude from Thornthwaite Table 6.
(5) PET converted to mm for Water Balance Computation.

WATER BALANCE DATA

MONTH	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
P.E.T.	0	0	15.2	50.8	104.1	142.2	172.7	152.4	104.1	58.5	25.4
P.	76.2	74.2	96.5	82.0	92.2	97.5	104.6	101.9	82.6	72.6	78.7
C	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
R/O	22.9	22.3	29.0	24.6	27.7	29.3	31.4	30.6	24.8	21.8	23.6
I	53.3	51.9	67.5	57.4	64.5	68.2	73.2	71.3	57.8	50.8	55
I-P.E.T.	+53.3	+51.9	+52.3	+6.6	-39.6	-74.0	-99.5	-81.1	-46.3	-7.7	+29.
Σ-(I-P.E.T.)				0	-39.6	-113.6	-213.1	-294.2	-340.5	-348.2	
ST	168.1	200	200	200	163	112	68	45	36	34	63.
ΔST	+53.3	+31.9	0	0	-37	-51	-44	-23	-9	-2	+29
A.E.T.	0	0	15.2	50.8	101.5	119.2	117.2	94.3	66.8	52.8	25
PERC.	0	20.0	52.3	6.6	0	0	0	0	0	0	0

SYMBOL		DESCRIPTION
P.E.T.	:	Potential Evapotranspiration
P.	:	Precipitation
C.	:	Coefficient of Surface Runoff
R/O	:	Runoff
I	:	Infiltration
I-P.E.T.	:	Infiltration Minus Potential Evapotranspiration
Σ-(I-P.E.T.)	:	Accumulated Negative Infiltration Minus Potential
ST	:	Soil Moisture Storage
ΔST	:	Change in Soil Moisture Storage
A.E.T.	:	Actual Evapotranspiration
PERC.	:	Percolation
FORMULAS	:	AET = PET + [(I-PET) - ΔST] (AET = PET when I - PERC. = P - R/O - ΔST - AET

3. Infiltration Quantities:

The Water Balance indicates that approximately 3.1 inches of the estimated 40.9 inches annual precipitation may infiltrate the fill and become part of the available water within the fill. The other 37.8 inches of precipitation will result in surface runoff or part of evapotranspiration. This phenomenon is expressed by the formula:

Net Infiltration = Precipitation - (Runoff + Evapotranspiration)

79 mm = 1,039 mm - (312 mm + 648 mm)

3.1 in. = 40.9 in. - (12.3 in. + 25.5 in.)

NOTE: Net infiltration may eventually result in percolation out of or away from the landfill. At field capacity, Input = Output.

The following computation indicates the estimated annual infiltration that will percolate into the landfill:

3.1" ÷ 12.0" = 0.26' annual infiltration,

54 landfill acres x .26' = 14.04 acre feet precipitation,

14.04 ac. ft. x 3.259 x 10^5 = 4,575,636 gallons/year,

∴ the estimated annual infiltration will be approximately 4.6 million gallons per year.

4. Underdrain System:

Leachate control will be provided by a system of underdrains. Permeability of the underlying clays in the proposed excavated areas is a major design consideration because it provides a natural barrier to contain potential migration of pollutants. Harrington, Lacey & Associates, Inc. performed three (3) field permeability tests according to the procedure in Earth Manual "Field Permeability Tests in Boreholes — Des. E-18" published by the Bureau of Reclamation, U.S. Department of the Interior, pp 541-545. Test locations are shown on the attached drawings.

UNIFIED SOIL CLASSIFICATION SYSTEM AND CHARACTERISTICS PERTINENT TO SANITARY LANDFILLS

Major Divisions		SYMBOL Letter	SYMBOL Hatching	SYMBOL Color	NAME	Potential Frost Action	Drainage Characteristics*	Value for Embankments	Permeability cm per sec	Compaction Characteristics †	Std AASHO Max Unit Dry Weight lb per cu ft †	Requirements Seepage Con
COARSE-GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		RED	Well-graded gravels or gravel-sand mixtures, little or no fines	None to very slight	Excellent	Very stable, pervious shells of dikes and dams	$k > 10^{-2}$	Good, tractor, rubber-tired steel-wheeled roller	125-135	Positive cutoff
		GP		RED	Poorly graded gravels or gravel-sand mixtures, little or no fines	None to very slight	Excellent	Reasonably stable, pervious shells of dikes and dams	$k > 10^{-2}$	Good,-tractor, rubber-tired steel-wheeled roller	115-125	Positive cutoff
		GM		YELLOW	Silty gravels, gravel-sand-silt mixtures	Slight to medium	Fair to poor Poor to practically impervious	Reasonably stable, not particularly suited to shells, but may be used for impervious cores or blankets	$k = 10^{-3}$ to 10^{-6}	Good, with close control, rubber-tired, sheepsfoot roller	120 -135	Toe trench to n[...]
		GC		YELLOW	Clayey gravels, gravel-sand-clay mixtures	Slight to medium	Poor to practically impervious	Fairly stable, may be used for impervious core	$k = 10^{-6}$ to 10^{-8}	Fair, rubber-tired, sheepsfoot roller	115-130	None
	SAND AND SANDY SOILS	SW		RED	Well-graded sands or gravelly sands little or no fines	None to very slight	Excellent	Very stable, pervious sections slope protection required	$k > 10^{-3}$	Good, tractor	110-130	Upstream blanket toe drainage or
		SP		RED	Poorly graded sands or gravelly sands, little or no fines	None to very slight	Excellent	Reasonably stable, may be used in dike section with flat slopes	$k > 10^{-3}$	Good, tractor	100-120	Upstream blanket toe drainage or
		SM		YELLOW	Silty sands, sand-silt mixtures	Slight to high	Fair to poor Poor to practically impervious	Fairly stable, not particularly suited to shells, but may be used for impervious cores or dikes	$k = 10^{-3}$ to 10^{-6}	Good, with close control, rubber-tired, sheepsfoot roller	110-125	Upstream blanket toe drainage or
		SC		YELLOW	Clayey sands, sand-clay mixtures	Slight to high	Poor to practically impervious	Fairly stable, use for impervious core for flood control structures	$k = 10^{-6}$ to 10^{-8}	Fair, sheepsfoot roller, rubber-tired	105-125	None
	SILTS AND CLAYS LL IS LESS THAN 50	ML		GREEN	Inorganic silts and very fine sands rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium to very high	Fair to poor	Poor stability, may be used for embankments with proper control	$k = 10^{-3}$ to 10^{-6}	Good to poor, close control essential, rubber-tired roller, sheepsfoot roller	95-120	Toe trench to no[...]
		CL		GREEN	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	Practically impervious	Stable, impervious cores and blankets	$k = 10^{-6}$	Fair to [...]		
FINE-		OL			Organic silts and organic [...]							

The following test results were obtained:

Test No.	Lithology Description	
1	Reddish brown clay to tan, very stiff to hard silty clay (CL) to clayey silt (ML)	3×10^{-6} cm./se
2	(same as Test No. 1)	2×10^{-6} cm./se
3	Tan, very dense, silty fine to medium sand	3×10^{-4} cm./se

The permeability tests indicate that the "upper clay" has a permeability within the 10^{-6} cm./sec. range and that the permeability of the so-called "upper sand" which contains some silt has a permeability within the 10^{-4} cm./sec. range. The range in permeability values is typical for SP, SM, ML, and CL sediments as the United Soil Classification System background data indicates.

Sandy sediments have greater permeability than clayey sediments. Therefore, areas where sand predominates are expected to have a permeability within 10^{-3} cm./sec. range. NOTE: The table on page 7 shows that the USCA materials SW and SP are expected to have a permeability k 10-3 cm./sec.

In general, where water flows through compacted layers of the waste within a landfill, its permeability is estimated to be approximately 1×10^{-4} cm./sec. (.0001 cm./sec.).

However, where water flows through a layer of course solid waste similar to industrial waste landfills and demolition/rubble fills, its permeability is estimated to be approximately 1×10^{-2} cm./sec. (.01 cm./sec.) or similar to gravels and gravel-sand mixtures with little or no fine particles. (GW and GP USCS materials.)

Based on the above data and background information, the following design permeability criteria have been determined:

a. General DHS waste: 1×10^{-4} cm./sec.

b. Clay barrier below excavation grade: 1×10^{-6} cm./sec.

c. Silty sand zones: 1×10^{-4} cm./sec.

d. Sand zones: 1×10^{-3} cm./sec.

An analysis of the underdrain system for areas I, II and III is given below:

Drainage System - Area I:

The spacing of underdrains is a function of the site conditions. The proposed drains are to be placed above top with an impermeable clay layer (permeability of 10^{-6} cm./sec.). The Ellipse Equation given below, has been used extensively to determine the spacing of underdrain:[1]

$$S = \sqrt{4K \frac{(m^2 \times 2\ am)}{q}}$$

where: S = drain spacing - feet
K = average hydraulic conductivity - in./hr.
m = vertical distance, after draindown, at water table above drain at mid point between lines - feet
a = depth to barrier below drain - feet
q = drainage coefficient - in./hr.

For area I the following data is used:

$K = 10^{-3}$ cm/sec (1.42 in./hr.)

m = 30 feet

a = 1 foot

q = 0.30 in./hr.

$$S = \sqrt{\frac{4 \times 1.42\ (30^2 \times 2 \times 1 \times 30}{.30}} = 246 \text{ feet}$$

Therefore, the recommended spacing is 250 feet of 4" tile as shown on the drawings.

NOTE: The value of m = 30 feet was selected to correspond to t anticipated water level elevation in Area III. The valu of q (0.30 in./hr.) is high (conservative) to include possible infiltration from high intensity storms.

Area II:

In this area the tiles will also be placed on top of the imperm clay layer. The same analysis performed for Area I is applicab here. One 4" line as shown on the drawings is recommended.

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[1] Drainage with Agricultrual Land/USDA SCS, Section 16 Natural Engine Handbook, 1971.

Area III:

The parameters for this area are:

$K = 10^{-3}$ cm./sec. (1.42 in./hr.)

$m = 5$ feet

$a = 30$ feet (estimated depth to impermeable layer)

$q = .30$ in./hr.

$$S = \sqrt{\frac{4 \times 1.42 \, (5^2 \times 2 \times 30 \times 5)}{}} = 143 \text{ feet}$$

The recommended spacing is 150 feet of 4" drain tiles as shown on the drawings.

5. Permeability Differential:

Permeability differential refers to the ratio between the permeability of the filled DHS and the buffer zone or clay barrier underlying the fill. The fill design will provide a natural or man-made clay barrier at the excavation grade to minimize the potential for leachate percolation into the underlying sediments.

The clay barrier will have permeability within the range of 10^{-6} cm./sec The design permeability of the DHS is 10^{-4} cm./sec. Therefore, the following permeability differential is computed:

$$\text{Perm. Diff.} = \frac{\text{DHS}}{\text{Clay Barrier Perm.}} = \frac{.0001 \text{ cm./sec}}{.000001 \text{ cm./sec.}} = \frac{100}{1}$$

In addition to the action of the basic permeability differential, the fill design will include a subsurface leachate collection system to promote positive, gravity flow of any potential leachate toward a leachate treatment system. In general, the combination of the clay barrier and leachate collection drain will minimize the potential for downward migration of leachate.

6. Estimated Leachate Quantity for SCM Tract:

The estimate leachate quantity is based on Darcy's Law where $Q = KiA$, where Q = total Leachate flow; k = permeability of the waste material or clay barrier; i = the hydraulic gradient; A = the cross-sectional area perpendicular to the flow.

The following parameters are used to estimate the vertical and horizontal leakage of leachate:

K (waste material)	=	10^{-4} cm./sec.
K (clay barrier)	=	10^{-6} cm./sec.
A (excavated area)	=	50 acres
Rainfall (effective)	=	3.1 in/yr = 2.6×10^{-7} cm./sec.
i (excavation grade)	=	$50.0 \pm$

a. Given a 50-foot section of waste:

$Q - KiA$

$$Q = 2.6 \times 10^{-7} \text{ cm./sec.} \times \frac{50 \text{ acres} \times 43560 \text{ ft.}^2}{30 \text{ cm./ft.} \qquad \text{acre}} = .019 \text{ cfs}$$

b. Lateral flow in clay barrier negligible because of zero gradient.

c. Flow into drainage tiles (assume gradient of 0.5; one side of a 50-acre square is 1,475 ft.)

$Q = KiA$

$$Q = 10^{-3} \text{ cm./sec.} \times \frac{0.5 \times 1475 \text{ ft} \times 50 \text{ ft}}{30 \text{ cm/ft}} = .123 \text{ cfs}$$

The above flow is through one side of a square area. The flow from four sides is:

$$.123 \times 4 = .49 \text{ cfs}$$

Ratio of lateral/vertical is $\frac{.49}{.019} = \frac{25.8}{1}$

Using the equation for flow to drain tiles:

$$Q = \frac{4K\, Yo^2}{L}$$

where L = drain spacing (assume 1000')
Yo = maximum elevation of saturated thickness

The lateral flow into the tile is:

$$Q = 4 \times \frac{10^{-4} \text{ cm./sec.} \times 50^2}{30 \frac{\text{cm}}{\text{ft}} \times 1000 \text{ ft}} \times 4 \times 1475 = .197 \text{ cfs}$$

Ratio of lateral/vertical is $\frac{.197}{.019} = \frac{10.4}{1}$

d. The above analysis indicates a ratio of approximately 1:10 (vertical to horizontal), assuming that the vertical flow is not obstructed.

The excavated layer is about 44 feet above M.S.L. Assuming a water table elevation of about 10 feet above M.S.L., the lateral flow in the layer between the water table and the bottom of the excavated material is (k (estimated) = 10^{-5} cm./sec. - i = 0.02)

$$Q = 10^{-5} \text{ cm./sec.} \times \frac{0.02 \times 4 \times 1475 \text{ ft}}{30 \text{ cm./ft.}} \times 26 \text{ ft} = .001 \text{ cfs}$$

Ratio of lateral flow (tiles) to maximum vertical flow is:

$$\frac{.197 \text{ cfs}}{.001 \text{ cfs}} = 197$$

since the vertical flow cannot exceed the maximum lateral flow.

Therefore, initially the ratio of vertical/horizontal flow is estimated at about 1:100; this ratio will increase to about 1:2000 when the bottom clay barrier approaches saturation.